ECONOMIC GEOGRAPHY
OF CANADA

Economic Geography of Canada

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TORONTO

THE MACMILLAN COMPANY
OF CANADA LIMITED

1947

Reprinted 1947

Printed in Canada

Press of The Hunter-Rose Co. Limited.

PREFACE

This book is the result of a suggestion of the late N. F. G. Davis that the two of us—the one trained in geology and the other in economics—should co-operate in describing the natural resources of Canada and the problems which have arisen in connection with their use. Unfortunately, Dr. Davis died before he could begin writing the sections for which he had assumed responsibility. By his death Canadian higher education was deprived of one of its most promising younger scholars and teachers, and students lost a friend to whom they always had felt free to come with their personal and academic difficulties.

The manuscript was read in its entirety by Dr. M. Y. Williams, Dr. H. V. Warren and Mrs. R. B. O'Brien of the Department of Geology and Geography in the University of British Columbia, and by Dr. W. T. Easterbrook of the Department of Economics in the University of Manitoba. In addition, the sections on agriculture were read by Dean F. M. Clement and Dr. V. C. Brink, also of British Columbia. The author is greatly indebted to all these experts for advice.

The footnotes acknowledge the author's obligation to numerous other scholars from whose published works he has drawn freely in writing this pioneer text on the economic geography of Canada. The author also wishes to record his thanks to various publishers for permission to reprint several maps and charts.

A. W. Currie

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INTRODUCTION

The word "geography" means a description of the earth. Yet modern geography is more than merely cataloguing details regarding the landscape, rocks, climate, flora and fauna, and the trade and customs of the people of a particular area. Geography aims at explaining *why* various regions of the earth possess the characteristics which they do. It is concerned with cause and effect, with origins and results. In short, it is scientific. In particular, it examines how land forms came into being (geomorphology); it treats of rocks and minerals and the agencies and processes which have been involved in their formation (geology); it deals with the factors which determine climate (meteorology); it considers the effect of climate on the natural distribution of plants and animals throughout the earth (ecology). In fact, geography draws upon a number of specialized sciences each of which studies the earth in one or other special aspect. For this reason it has been called "the correlative science".[1]

Not content with pilfering knowledge from almost all the physical sciences, geography studies parts of the social sciences as well. Fundamentally it is concerned with the earth *and* man; with the inter-relationship of man and his environment. The study of these inter-relationships may involve the effect of the physical world on the course of past history or future development (geopolitics), or on the races of men (anthropogeography), and so on. Undoubtedly, the most important of these interconnections is that which considers the effect of the physical world on the ways in which man gets a living. How does the physical

[1]Taylor, G., "Geography, the Correlative Science", *Canadian Journal of Economics and Political Science* (hereafter referred to as *C.J.E.P.S.*) vol. 1, November, 1936, pp. 535-50.

environment, or the natural resources, affect the methods men use to provide themselves with food, clothing, shelter, and articles of trade? This is the field of *economic* geography.

The purpose of this book is to deal with the economic geography of Canada and Newfoundland. It is recognized that the economic problems arising from the use of resources in Canada are not peculiar to the Dominion but have marked similarities to adjacent sections of the United States and, in certain districts, to Scandinavia and Russia. Unfortunately, the existing publications on the geography of North America give scant attention to British territories and what little is contained is often inaccurate. More important, Canada and Newfoundland are separate political entities and the proper solution of many of their pressing problems presupposes an understanding of their physical environment. A knowledge of what these Dominions have in the way of natural resources, of how these are being used at present, and of attempts toward the better use of these resources is a pre-requisite to intelligent national planning for the future.

It is obvious that the study of the economic geography of a large area like Canada and Newfoundland can be handled effectively only by breaking down the area into smaller divisions or Regions and dealing with each one of these in turn. A geographic Region can be defined as an area which, without being absolutely uniform throughout its entire expanse, has yet enough features in common to be looked upon as a unit. At the same time it must be sufficiently different from the surrounding areas to be considered distinct. The object of dividing a nation up into Regions is to make the maximum number of accurate statements about it with the minimum necessity for considering minor details.

As a matter of fact, it is very difficult to arrive at a proper theoretical basis of uniformity and distinction. It is still more difficult to apply the principles to a particular section of the

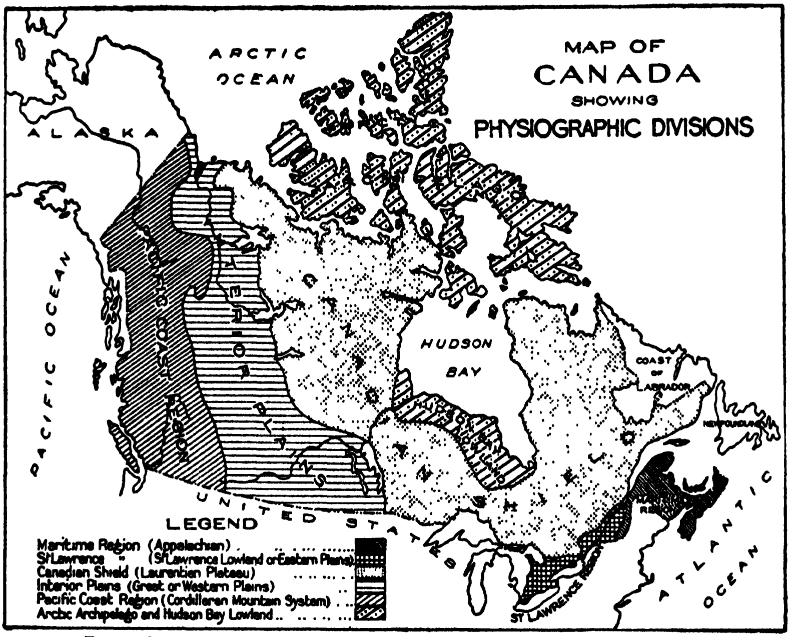
earth's surface. Many plans have been devised for subdividing continents and countries into geographic Regions.[2] Annual precipitation, average temperature, native flora, soil, geological structure, physiography, types of agriculture or other economic activity, political sub-divisions, and combinations of these have been used by various scholars. Each one of these plans has its advantages but none is wholly satisfactory for all purposes. The plan selected for this book is, in the main, the physiographic one, that is, the one based on relief, or topography, or the general appearance of the surface of the earth. This basis was chosen because the existence of mountains, plateaus, hills, plains, lakes, and rivers cannot be questioned. These features are also relatively permanent in their character and have an important effect on the soil, mineral resources, climate, flora, and the general type of economic life. Finally, the physiographic provinces do not overlap each other as do some of the other bases. Physiography will not be followed to the detriment of clarity of presentation of material or to the extent of repetition of data. Nevertheless it will form the broad foundation of most of the Regions.

For the purposes of this book Canada is divided into seven distinct Regions—Acadian-Appalachian, St. Lawrence Lowlands, Prairies, Cordillera, Shield, Mackenzie Valley and Hudson Bay Lowland, and the Tundra. Newfoundland and Labrador really represent the northeastern extension of two of the Canadian

[2]Atwood, W. W., *The Physiographic Provinces of North America* (Boston: Ginn & Company, 1940), pp. 3-22; Baker, O. E., "Agricultural Resources of North America", *Economic Geography*, vol. 2, October, 1926, pp. 459-93; Fenneman, N. M., "Physiographic Boundaries within the United States", *Annals*, Association of American Geographers, vol. 4, 1914, pp. 84-134; "Physiographic Division of the United States"; *ibid.*, vol. 18, 1928, pp. 261-353; Gaus, J. M., Crane, J., Dimock, M. E., and Renner, G. T., *Regional Factors in National Planning and Development* (Washington: 1935); Hartshorn, R., "The Nature of Geography", *Annals*, vol. 29, 1939, pp. 171-469; Joerg, W. L. G., "The Subdivision of North America into Natural Regions", *Annals*, vol. 4, 1914, pp. 55-83.

physiographic provinces but since they constitute a separate political unit, they will be dealt with by themselves in Chapter IX.

The easternmost Region in Canada is the Acadian-Appalachian. This Region is composed of narrow bands of hard rock



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with a few patches of fertile soil. Geologically it is a series of worn-down mountain ranges. It includes the three Maritime Provinces, New Brunswick, Nova Scotia, and Prince Edward Island. It also incorporates the Gaspé peninsula and the Eastern Townships of the province of Quebec. Its main occupations are fishing, coal mining, the raising of apples, potatoes, and silver fox furs. Subsidiary industries are forestry, manufacturing, and recreation.

The St. Lawrence Lowlands have a more complete and well-

rounded economy than that of any other Region in the country. Strictly speaking, they comprise two or three physiographic provinces or sections of provinces but these are so similar in the nature of their economic life that they are here considered as one. The Lowlands include those parts of Canada which lie west and south of a line drawn from the foot of Lake Ontario to the southern tip of Georgian Bay. They also include the Ottawa and St. Lawrence valleys below Renfrew and Brockville which are, respectively, 150 and 100 miles west and southwest of Montreal. They extend down the St. Lawrence as far as Quebec city with a narrow strip on the north bank and a broader belt south of the river. The backbone of economic activity in the Lowlands is a well diversified agriculture. In certain sub-regions farming is specialized in the sense that it pays particular attention to one product or another, but the chief feature of agricultural production is the wide range of farm goods which are grown in every district. Manufacturing of a large volume and variety of goods is also very important. The generation of hydro-electricity, forestry, mining, and the tourist industry are significant. Taken altogether, these occupations make the Lowlands the economic heart of Canada.

The Prairie Region is physiographically a triangular-shaped area north of the forty-ninth parallel, east of the Rocky Mountains and southwest of a line drawn from the southeast corner of Manitoba to the mouth of the Mackenzie River. The lower half of the Mackenzie Basin, though topographically part of the Prairies, is treated in a separate chapter along with the Hudson Bay Lowlands because its business activities are quite different from those of the southern part of the Plains. For our purposes the Prairies will include only those sections of the Plains drained by the Nelson-Saskatchewan system and the upper parts of the valleys of the Peace and the Athabaska. In the Prairie Region

so defined, the most important industry is agriculture and the most important single product is wheat.

The Cordillera Region comprises the mountains and plateaus of British Columbia and the Yukon with the narrow eastern face of the Rocky Mountains in Alberta. This Region has a greater range of climate and terrain than any other one in Canada. The chief industries are mining, fishing, lumbering, and agriculture.

The Canadian Shield, though one of the most recently developed parts of the Dominion, is already one of the most important. It is a huge horseshoe of hard crystalline rock surrounding Hudson Bay and contains half the total area of Canada. It does not include the coastal plain to the south of Hudson Bay and west and south of James Bay. In the Shield the chief industries are connected with mines, forests, and fur-bearing animals.

The lower Mackenzie Valley and the Hudson Bay Lowland have somewhat similar topographic features. They are several hundred miles apart but because they face much the same economic problems they are dealt with in the same chapter.

The Tundra is marked off from other Regions by the nature of its flora rather than its topography. It incorporates the upper arms of the Shield, and the Archipelago north of Canada. Economic activities are naturally restricted by the climate and are carried on by aborigines, with white men in control of trade.

The boundaries of each of these Regions will be defined more carefully in the chapter assigned to each. The book will deal first with some broad factors affecting Canada as a whole and then treat each of the seven Regions in detail. The final chapter will describe the economic geography of Newfoundland and Labrador.

ECONOMIC GEOGRAPHY OF CANADA

Chapter I

CANADA AS A WHOLE

THE DOMINION OF CANADA consists of the whole northern part of the continent of North America with its adjacent islands except the United States territory of Alaska, the Danish colony of Greenland, the British possessions of Newfoundland and Labrador, and the two small French islands of St. Pierre and Miquelon. In other words, it takes in all the area north from the United States boundary to the North Pole, west of the Atlantic Ocean, Davis Strait and the sixtieth meridian (except Newfoundland, Labrador and the French islands), and east of the Pacific Ocean and Alaska. Its total area is 3,694,863 square miles. It is nearly as large as the United States and its dependent territories and includes 27 per cent of the area of the British Empire.

Huge as Canada is in total area, the *ecumene* or utilized land of the country is relatively small—375,000 square miles according to Jefferson.[1] The greater part of the immense northern section remains virtually an undeveloped wilderness. Though the Dominion extends over 1,500 miles from north to south, the settled area averages less than 200 miles. In fact, one-half the population lives within 100 miles of the United States boundary and about 90 per cent within 200 miles. The development of mining and lumbering in the Shield and the use of the aeroplane is steadily rolling back the map of settlement but it is still basically true that Canada is a strip of territory north of the United States.

This strip or *ecumene* is not continuous. Instead it is broken up into segments by wide stretches of unproductive rocks. The

[1] Jefferson, Mark, "The Problem of the *Ecumene*; the Case of Canada", *Geografiska Annaler*, vol. 16, 1934, pp. 146-588.

Maritime Provinces are separated from the province of Quebec by a barren zone in the Gaspé peninsula. Between the St. Lawrence Lowlands and the Prairies is the wide belt of the Shield. The Pacific coast cities with their fisheries, lumbering and overseas trade are cut off from the agricultural plains by the thinly populated Rocky Mountains and interior plateau. Only along the boundary between the Shield and the Lowlands is there any substantial blending of occupations. The important businesses of one Region do not, generally speaking, merge gradually into the economic life of the next. The result is that each Region tends to have its own peculiar economic and political interests. For example, the Acadian-Appalachian Region desires foreign markets for its potatoes, apples, and newsprint, and more trade for its merchant marine and seaports. In the main it prefers lower tariffs, except as regards its iron and steel industry which operates under serious physical handicaps. On the contrary, the St. Lawrence Lowlands insist on high protection because, largely for geographic reasons, they are heavily industrialized. In the same way there are cleavages of interest between the other economic Regions.[2]

This geographic sectionalism is aggravated by the difference in viewpoint between the French-speaking Canadians in Quebec and other provinces and their English-speaking compatriots. The fundamental political problem in Canada is to integrate the seven economic Regions into one nation. "The formation of the Dominion in 1867 was a political triumph over the hard facts of geography. But the victory was not complete; geography was not annihilated. Geographic facts have again and again reasserted themselves in Canadian history. Sectionalism has been

[2]Lower, A. R. M., "This Island Nation", *Canadian Defence Quarterly*, 1937, pp. 489-507; Sage, W. N., "Geographical and Cultural Aspects of the Five Canadas", Canadian Historical Association, *Annual Report*, 1937, pp. 28-34; Scott, F. R., *Canada Today* (Toronto: Oxford University Press, 1939), pp. 1-62.

a recurring phenomenon in politics and distance an inescapable condition of economic life. The maintenance of national unity against the decentralizing tendencies of geography has been an ever-present problem of public policy, alike in domestic and external affairs."[3]

Transportation and Communication

In an effort to integrate the *ecumene* and thus attain national unity, the Canadian public has become deeply involved in the provision of transportation and communication services.[4] In the 1840's the government aided the construction of canals along the St. Lawrence River with the hope of drawing the traffic from the American Middle West, then just being opened up, through the port of Montreal in competition with the Erie Canal and New York city. After 1850 these canals were rendered more or less obsolete by railways and so the Grand Trunk Railway was built from Chicago through Toronto and Montreal to Portland, Maine, with the same object in view. Though this road was financed mainly by private investors in Britain, the government in Canada had to come to its aid on one occasion to prevent bankruptcy. As a direct result of Confederation, the Intercolonial Railway was constructed by the new Dominion government from Montreal to Saint John and Halifax entirely through Canadian territory. In the 1880's the Canadian Pacific Railway was generously subsidized with cash, land, and certain completed lines to build a line from the Ottawa Valley to the Pacific coast.

[3]Mackay, R. A., and Rogers, E. B., *Canada Looks Abroad* (Toronto: Oxford University Press; 1938), p. 12.

[4]Currie, A. W., *Canadian Economic Development* (Toronto: Thos. Nelson & Sons, Limited, 1942), pp. 102-14, 244-66; Glazebrook, G. P. de T., *A History of Transportation in Canada* (Toronto: Ryerson Press, 1938); Innis, H. A., *A History of the Canadian Pacific Railway* (London: P. S. King, 1923); "Transportation as a Factor in Canadian Economic History", *Proceedings*, Canadian Political Science Association, vol. 3, 1931, pp. 166-84; Jackman, W. T., *Economic Principles of Transportation* (Toronto: University of Toronto Press, 1935).

After many unprofitable years the Canadian Pacific began to pay dividends due to rapid development in the West, a growth of mining in northern Ontario and southern British Columbia, an increase in trans-Pacific trade, and the ability shown by the management.

In the early part of the twentieth century Dominion, provincial and municipal governments guaranteed the interest and principal of the bonds of two other transcontinental railways which were built by privately-owned corporations. These lines were not complete before the outbreak of the first Great War, which raised the cost of labour and construction materials, closed the money markets of the world to private borrowers, and forestalled the agricultural and mining development along the routes which might, under more propitious circumstances, have contributed enough traffic to make the lines pay. By 1917 the new railways were on the verge of bankruptcy. If they had gone into official receivership the credit of the Dominion which had so heavily guaranteed the bonds would have been adversely affected at the very time when a strong financial position was urgently needed to carry on hostilities. As a result, the Dominion government was forced gradually to assume responsibility for the two new transcontinental lines as well as for the Grand Trunk and the Intercolonial.

There are at present only two large railways in Canada. The Canadian Pacific is privately owned and financially sound even though it had to defer dividends during the depression of the 1930's. The Canadian National, which consists chiefly of the lines taken over by the Dominion during and after the first World War, is managed by a corporation controlled by the government. Except in occasional years with a very high volume of traffic, the Canadian National operates at a loss which is borne by the general public through taxes. The average freight rates in Canada are almost the lowest in the world and part of the

deficit on the Canadian National must be attributed to the low rates charged to trade and industry, especially on goods for export.

Since 1900 the canal system has been steadily enlarged to accommodate the bigger vessels now in use on the Great Lakes. At Sault Ste. Marie two canals, one Canadian and the other American, annually handle more traffic than either the Suez or Panama, in spite of the fact that they are closed by ice for five months every year. These canals enable vessels to circumnavigate the rapids on the St. Mary's River between lakes Superior and Huron. In 1932 a greatly improved Welland Canal was opened for traffic, replacing the smaller and less efficient canal previously in use. Along the 28 miles of the "New Welland" there are only eight locks, all electrically operated. The minimum depth of water in the locks is 30 feet though the channel between the locks has not yet been dredged below 25 feet. The canal overcomes the difference of 326 feet in the elevation of lakes Erie and Ontario.

From Prescott, sixty miles below Kingston which is at the foot of Lake Ontario, to Montreal there is a series of rapids and a total drop of 226 feet. The six canals built to overcome these rapids have a minimum depth of only 14 feet. A proposal to enlarge the canals so that the large upper lake vessels might go down to Montreal and medium-sized ocean-going vessels might steam up the rivers and lakes to Toronto, Detroit, Chicago, Duluth and Fort William is being jointly considered by the governments of Canada and the United States. The merits of the St. Lawrence waterway are doubtful from a navigation standpoint but the project will also develop large amounts of hydroelectric energy.

The most important traffic handled by Canadian vessels along the Great Lakes and the St. Lawrence is grain from Fort William and Port Arthur to Montreal or, chiefly, to Buffalo whence it

moves by rail to New York for export. A good deal of traffic in coal, iron ore, and package freight moves between Canada and the United States, and miscellaneous freight between Canadian ports. There is also a large volume of purely United States traffic. Despite the fact that the route is closed by ice for at least five months each year, it is of inestimable value to Canada. It gives relatively cheap transportation on bulky articles literally from the heart of the continent to the markets of the world. It must be emphasized that this is made possible only by enormous expenditures by the government in canals, dredged-out channels without locks, lighthouses, radio stations and other aids to navigation. No tolls are charged for the use of any of these facilities.

In addition to aiding railways and canals the government assists ocean shipping, commercial aviation, and highway traffic. The government through a subsidiary corporation operates the only transcontinental networks of radio broadcasting stations. On the Prairies the telephone systems are owned by the provincial governments.

In short, governments in Canada have given substantial financial assistance to transportation and communication. The chief justification for this aid is the urgent necessity for overcoming the basic difficulty in the Canadian confederation, namely, the separation of the various physiographic and economic Regions of the country. It is often said that Canada is a "triumph over geography" and a "country of magnificent distances". Both statements are true. The provision of adequate transportation facilities is essential in order to develop the large but scattered resources of the country and to lend unity to the nation as a whole. The division of Canada into Regions is not a device arbitrarily adopted by the economic geographer to suit his own convenience. It is a basic fact in the country's economic and political life. Cheap, speedy transportation and communication are means of offsetting the harmful effects of geographic regional-

ism. They are also instrumental in permitting Canada to sell her products in world markets in competition with other nations.

Foreign Trade

Canada occupies a very important position in international trade.[5] With less than one per cent of the world's population she normally carries on between three and four per cent of the world's total export trade. In peacetime years Canada rated fifth among the trading nations in the total value of her trade, being exceeded only by the United Kingdom, the United States, Germany, and France. On a per capita basis in 1929 Canada was outranked by three countries—New Zealand, the Netherlands, and Denmark. In 1939 she was out-rivalled by these countries and four more—Norway, Belgium, Switzerland, and Spain. Usually Canada's foreign trade per capita is about three and a half times that of the United States.

In the early years of the Dominion, Canadian exports were almost entirely raw materials and her imports manufactured goods but in 1942 the exports were classified as being about 30 per cent raw materials like wheat, 30 per cent partly manufactured, like flour, and nearly 40 per cent fully manufactured. Of the imports, 30 per cent were raw materials, 10 per cent were partly manufactured, and 60 per cent fully manufactured. It is obvious that, contrary to popular belief, Canada is an important exporter of manufactured goods. Indeed, on a per capita basis she exports three times as much manufactures as the United States, though her total exports of these goods are not nearly as large as those of the Republic on account of the

[5]Currie, *op. cit.*, pp. 87-101, 267-83; Dominion Bureau of Statistics, *Canada's Balance of International Payments* (Ottawa: King's Printer, 1939); Mackay and Rogers, *op. cit.*, pp. 13-49; Mackintosh, W. A., "The Economic Background of Dominion-Provincial Relations", Appendix 3, *Report of the Royal Commission on Dominion-Provincial Relations* (Ottawa: King's Printer, 1940); Michell, H., "Trade, External", *Encyclopedia of Canada* (Toronto: University Association, 1935-7).

difference in population. One of the important reasons for Canada's prominence as an exporter of manufactured articles is the British preferential tariff which enables Canadian-made goods to enter every part of the Empire on more favourable terms than those accorded goods of United States manufacture.

The causes for Canada's importance in foreign trade generally lie in the nature of her geographic resources. Although Canada's resources are very great in certain directions, she is precluded by her climate and lack of certain minerals from producing many articles of fundamental importance in modern life. The Dominion produces five times her own consumption of wheat (excluding seed requirements); ten times her own consumption of newsprint; and twenty times her own requirements of non-ferrous metals such as copper, nickel, lead, and zinc. She also produces large exportable surpluses of many other articles—potatoes, apples, dairy products, pine and fir lumber, pulpwood, and gold. On the other hand, Canada either cannot produce, or can produce only in small quantities, such essential raw materials as iron, rubber, tin, cotton, sisal, tropical fruits, and many iron and steel and chemical manufactures. "Every country could, of course, display a list of surplus and deficit resources, but in few would both sides of the balance sheet contain such basically important products in such volume, and in few would the extremes be so great. Thus, Canada is at once the world's largest exporter of wheat, newsprint and non-ferrous metals, and one of the world's largest importers of coal, oil [petroleum] and steel products. It is in this distribution and peculiar character of Canada's resources, and in her lack of resources, that can be found the explanation for many of Canada's distinctive economic and public finance problems."[6]

Many of the exports are bulky and are sold in relatively distant markets. Hence the provision of cheap and efficient transpor-

[6]*Canada Year Book, 1941* (Ottawa: King's Printer), p. 405.

tation services is essential, as already pointed out. The development of the resources necessitated a huge capital investment in agricultural and industrial machinery, in buildings, hydro-electric power plants and in railways, canals, grain-handling facilities, docks, and ships. On account of the climate some of this capital equipment can be used for only a relatively short time each year. Since the charges for interest, maintenance, depreciation and obsolescence go on throughout the entire year, the cost per unit of output during the short season is higher than it would be if the capital equipment could be used more continuously. The money to construct these permanent facilities had to be borrowed from abroad, mainly from Britain before the first Great War and from the United States since 1920. Interest on this indebtedness must be met annually and eventually the principal will have to be paid. Before the outbreak of the second World War Canada was paying off her foreign debt at a rate which fluctuated from year to year with the selling prices of Canadian exports in the foreign market and the amount of new borrowing. During the second World War the rate of payment was accelerated by the sending to Canada by the British government of Canadian securities held by the people of Britain. When these securities were sold in Canada they provided Britain with dollars to meet part of the cost of war materials exported from Canada for use by British troops and civilians. Although this wartime repatriation of securities will reduce the debt of three billion dollars which Canada owed Britain in 1939, it will have little effect on the four billions owed the United States. For this reason and also because of the probability of increased investment in the development of Canada's resources after the war, the foreign indebtedness is likely to remain substantial even after the cessation of hostilities.

It might be considered that the existence of a heavy foreign debt would be no serious handicap on Canadian economic devel-

opment, because if the money has been wisely invested it should provide revenue and thus the means for the repayment of the debt. This is probably the case with the great bulk of the outside investment in Canada. Though investors in money-making enterprises often invest part of their profits in other business ventures within Canada, usually they wish to take at least some of their interest and dividends outside the Dominion of Canada. In addition to investments in business corporations, people living outside Canada have invested large amounts in the bonds of federal and provincial governments which have borrowed abroad to construct railways, hydro-electric power plants and distributing systems, telephone systems and for general government purposes. The interest on this investment must be met annually—unless the governments default their obligations, which no British country has ever done.

Since the investment by outsiders in Canada totalled about seven billion dollars in 1939, the aggregate payments which Canadians must make abroad annually for interest at 3 to 5 per cent on government and private debt and dividends on the preferred and common stocks of corporations is very large. Canada must also pay outsiders for the services they render Canadians such as carrying Canadian goods to market, insuring Canadian ships, or making motion picture films to be shown in Canada. Most important of all, Canadians are obligated to pay for the large quantities of iron and steel, petroleum, tropical and semi-tropical articles and the host of other imports which Canadians demand. In short, Canadians have large financial obligations in other countries, chiefly in Britain and the United States. These must be satisfied every year if Canada is to continue to import goods and to maintain her high credit rating in the world's financial markets.

These obligations abroad can be met in three ways. Goods, the products of Canada's natural resources and the results of the

people's physical and mental efforts, can be sent abroad. Goods and services can be supplied to tourists, mainly American, travelling within Canada. Finally, Canada can provide services to the citizens of other nations, such as carrying American goods across Canada between the Detroit and the Niagara frontiers, or lending capital to Brazilians and Jamaicans to construct public utilities, or building railway lines like the Canadian National (Grand Trunk Western and Central Vermont) or the Canadian Pacific (in Maine and Vermont), or constructing branch plants of Canadian companies in the United States. The total amount of loans and investments by Canadians in other countries is about one billion dollars. This investment should be set off against the investment by the nationals of other countries within Canada. Yet even after considering this factor, there remains a very large sum to be met abroad on account of the net balance for interest, for shipping and other services, and for imports of merchandise. In order to meet this huge payment a very large export of goods is absolutely essential.

Thanks to her great natural resources, the energy of her people, and ample capital equipment, Canada is physically capable of carrying on an enormous export trade. Unfortunately, the prices of the goods which she exports are subject to marked fluctuations with the business cycle. At the same time, the prices of the manufactured goods which Canada buys abroad may not be reduced at the same rate or to the same degree as the prices of the goods exported from Canada. Certainly the heavy interest charges on the foreign debt will not be cut down materially. The tourist trade within Canada is essentially a luxury trade and fluctuates greatly in value from one year to another. In short, in times of depression, the amount of Canada's indebtedness abroad on account of interest, foreign services and imports of goods may decline only slightly, whereas the values of the goods she exports and the value of services rendered to tour-

ists may be reduced considerably. In the prosperity phase of the cycle the reverse situation may be the case. Then, everything proceeds in a state of boundless optimism and Canadians borrow heavily abroad, without realizing that the interest and possibly the principal may have to be repaid when the terms of trade are unfavourable. In brief, wide disparity in the prices of the goods and services exported will cause a world-wide depression to impinge with unusual severity on the Canadian economy. The same situation will magnify the prosperity of good times. All this is complicated by the fact that increases in tariffs by foreign countries, especially by Britain and the United States with whom 80 per cent of Canada's external trade is transacted, may deal shattering blows to the Canadian economy.

To sum up, if the significance of Canada's foreign trade consisted in no more than statistics of total exports and imports, of rank relative to that of other nations, and of particular commodities moving across her boundaries, all would be pleasant reading. The fact is that the influence of the factors bearing on the volume and value of external trade in goods and services permeates the entire structure of Canadian economic life. At least one-third of the total income of Canadian people arises directly from the export of goods abroad. A much larger proportion of the income is secured from the production within the Dominion of articles and services which are sold to the workers in the export trades. Beyond all this is the fact that the fluctuations in the volume and value of foreign trade determine the tempo of Canadian business life and the standard of living of the Canadian people.

Population

According to the 1941 census the total population of Canada was 11,507,000—about one-twelfth that of the United States or one-quarter that of the United Kingdom (including Northern

Ireland). The density of population was 3.29 per square mile if the whole area of the country is considered but is 30.7 per square mile on the basis of the settled territory or *ecumene*. This compares with 489 in Great Britain and Northern Ireland (1931) and 43.42 in continental United States (1940).

The Canadian population has grown from 3,700,000 in 1871 and 5,400,000 in 1901. At times, especially from 1900 to 1913, there was a very large immigration from Europe but this was offset by emigration of large numbers, chiefly of Canadian born, to the United States. In the 1930's the natural increase (the excess of births over deaths) was about 120,000 per annum and the annual net immigration approximately 15,000. The natural rate of growth of the population is declining in Canada as it is in the United States, Britain and most of the countries of Europe.[7] This is due mainly to a falling off in the birth rate caused by postponement of marriage and restriction in the size of the family. This decline has been proceeding steadily for the last century and a half. For most of this period it has been more than counterbalanced by a decided decline in the death rate, with the result that the population of nations of European descent has increased steadily. Medical science has been particularly successful in reducing infant mortality and controlling diseases like tuberculosis, measles, scarlet fever and typhoid fever to which the young are peculiarly susceptible. Although science has made it possible for more infants to reach maturity, it has not signifi-

[7]Bladen, V. W., "Population Problems and Policies", in Martin, Chester, *ed.*, *Canada in Peace and War* (Toronto: Oxford University Press, 1941), pp. 86-119; Bladen, V. W., *An Introduction to Political Economy* (Toronto: University of Toronto Press, 1941, pp. 64-95; Dublin, I., *ed.*, *Population Problems in the United States and Canada* (Boston: Houghton Mifflin Company, 1926); Hurd, W. B., "Some Implications of Prospective Population Changes in Canada". *C.J.E.P.S.*, vol. 5, November, 1939, pp. 492-503; MacGibbon, D. A., "Population Policies, the Economic Policies Necessary to Implement Them", *Canadian Papers* (Toronto: Canadian Institute of International Affairs, 1938).

cantly increased the span of life beyond the traditional threescore years and ten. The result is that the number of elderly persons comprises a much larger proportion of the population than formerly, while the number of young people has become relatively fewer. On account of the larger number of older people and the failure of science to discover the secret of longevity, the number of deaths will inevitably rise in future years. If the decline in the birth rate continues, the natural increase in the population will necessarily fall off. This trend will likely be progressive because as time goes on there will be fewer and fewer potential fathers and mothers. Eventually the population will become stable in numbers and there may even be a decline in the total, as has already happened in France. In short, as the age composition of the population becomes more favourable to deaths and less favourable to births, the rate of natural increase will decline.

Immigration into Canada is not likely to recover to its 1913 peak of 401,000 nor even to the inter-war maximum 167,000 in 1928. Although some people will doubtless desire to emigrate in order to escape the danger of another Great War in Europe, the days of mass immigration into Canada appear to be definitely over. In Europe the number of men and women in their early twenties who have heretofore formed the chief age group from which immigrants are drawn, will be smaller after the war than ever before due to the natural changing of the age composition of the population there and to the ravages of the war itself. The source of supply of immigrants is drying up. Also Canada may not be able to provide a livelihood for large numbers of newcomers without adding to the unemployed in times of depression and driving native-born Canadians to the United States. Moreover, Canadians as a group are probably unwilling for cultural and religious reasons to accept large numbers of Central Europeans, who are the racial groups most anxious to come. Finally,

Canadians want settlers on farm lands; but the bulk of the immigrants of the 1930's went to the cities despite all official efforts to encourage agricultural settlement. If it is true that the flow of immigration will decline and if at the same time the rate of natural increase is diminishing, then the population of Canada will grow less rapidly in the future than it has in the past. Competent authorities, using official data for their calculations, estimate that the population of the Dominion will reach a maximum of 15,401,000 in 1971 and will thereafter become stable or decline slightly.

Of the total population nearly 50 per cent is of British and about 30 per cent of French racial origin. The minor racial groups that help compose the nation are German, Scandinavian, Ukranian, Hebrew, Polish, Dutch, and many others. There are fewer than 120,000 Indians and about 7,200 Eskimos. Nearly 35,000 Chinese are scattered throughout the cities of Canada, and 23,000 Japanese were engaged in fishing, truck gardening and lumbering along the Pacific coast until they were moved into the interior as a precautionary measure during the second Great War. Many of these races are not readily assimilated into either one of the dominant races of the Dominion. They tend to retain their own language, religion and customs, becoming "ethnic islands" within Canada. The second generation is slowly being Canadianized but the process of acculturation is slow.[8]

The cultural separation of the English- and French-speaking elements has persisted since the British conquest in 1760 and the first large-scale immigration of people of Anglo-Saxon descent, the United Empire Loyalists from the newly created United

[8]Dawson, C. A., *Group Settlement: Ethnic Communities in Western Canada* (Toronto: The Macmillan Company of Canada Limited, 1936); Gibbon, J. M., *Canadian Mosaic* (Toronto: McClelland & Stewart, Ltd., 1938); Hurd, W. B., and Grindley, T. W., *Agriculture, Climate and Population of the Prairie Provinces of Canada* (Ottawa: Dominion Bureau of Statistics, 1931), pp. 79-96.

States, in 1783. Racial distinction is aggravated by differences in religion and in general approach to economic and political matters.[9] In general, the English-speaking Canadians are aggressive, interested in material things, and so naturally control the important commercial and industrial concerns in the country. The French-speaking Canadians are more interested in agriculture than in big business. They take satisfaction from their religious observances rather than in large possessions. The two races live side by side in peace. For the most part they happily escape the positive ill will which characterizes the relations of the whites and the negroes in the southern United States, for example. At the same time, there is little coalescence of ideals or mingling of the two groups in ordinary social life. Political unity is maintained only by compromises on all sorts of questions such as education, participation in foreign wars, and the extent of social security legislation. The cost of government is increased through the necessity of publishing all official documents of the federal government in both languages and by having separate schools for Protestants and Roman Catholics in most of the provinces.

The occupations of the gainfully employed persons in Canada indicate the relative importance of the various economic activities. According to the census, a "gainful" occupation is one by which a person pursuing it earns money or money equivalent or assists in the production of marketable goods. Children in general housework or chores, and housewives are not included. In 1941, 4,511,000 persons, 39 per cent of the population and 53 per cent of the population 14 years or over, had some gainful occupation though they might not have been actually employed at the date of the census. The number engaged in agriculture exceeded those in any other occupation in every province except British Columbia. The numbers in forestry and

[9]Bovey, W., *Canadien* (Toronto: J. M. Dent & Sons (Canada) Ltd., 1938); Siegfreid, A., *Canada* (London: Jonathan Cape Limited, 1937).

fishing appear quite small for the reason that the census authorities consider that the processing of the raw materials of these two industries, that is, saw-milling and fish-curing and packing, is manufacturing rather than lumbering and fishing. The proportion in manufacturing is highest in Ontario and Quebec, and the percentage in mining is greatest in Nova Scotia and British Columbia. Services include barbers, beauticians, waitresses, domestics and so on, as well as doctors, teachers, lawyers and other professional men and women. It is to be noted that in the following table the data are by provinces or groups of provinces, not by economic-geographic Regions used in the remainder of this book.

GAINFULLY OCCUPIED MALES
14 years of age and over
(by occupational groups—1941)

	Maritimes %	*Quebec* %	*Ontario* %	*Prairies* %	*British Columbia* %	*Canada* %
Agriculture	32	27	23	56	16	32
Fishing-Logging	12	4	2	2	10	4
Mining	5	1	2	2	4	2
Manufacturing	11	19	23	8	17	17
Construction	6	7	6	3	7	6
Transportation	9	8	8	6	10	9
Trade, Finance	6	9	10	8	10	9
Service	6	10	10	8	12	9
Clerical	3	6	7	3	5	5
Labourers*	8	8	8	4	10	7
Total Number (000)	299	928	1,140	737	259	3,363

*This group does not include agricultural, fishing, logging, or mining labourers.

Source: Appendix III, *Canada Year Book, 1943-44*. Data exclude males on active service except those gainfully occupied before enlistment. It also includes the unemployed in the occupation in which they were last employed.

A further indication of the comparative importance of the various economic activities is shown by the following table of net value of production of different industries by provinces in 1941. These data, compiled by the Dominion Bureau of Statis-

tics, represent an estimate of the amount contributed to the national economy by the various industrial groups. "Net" production represents an attempt to eliminate the value of raw materials, fuel, purchased electricity and processed supplies consumed in the production process. For the purposes of ordinary economic discussion, the net figure is used in preference to the gross value of production in view of the large amount of duplication included in the latter. Because the data were originally expressed in dollars, the percentages show the influences of price changes as well as of wartime activity. Nevertheless, they are reasonably representative of this aspect of the Canadian economy under normal conditions.

NET VALUE OF PRODUCTION
(by industries—1941)

	Maritimes	*Quebec*	*Ontario*	*Prairies*	*Br Col.*	*Yukon**	*Canada*
	%	%	%	%	%	%	%
Agriculture	18	12	14	58	10		20
Forestry	16	13	5	2	26	†	9
Fishing	6	†	†	†	6	†	1
Trapping	1	†	†	†	†	33	†
Mining	10	10	11	8	16	64	11
Electric Power	4	5	3	3	5	†	4
Construction	8	6	5	5	7		6
Custom and Repair	3	3	3	3	3		3
Manufactures**	36	64	65	21	47	2	55
Total ($000,000)	254	1,279	2,088	710	380	8	4,720

*Includes Northwest Territories.
†Less than one per cent.
**Includes saw-mills, pulp and paper mills, fish processing and certain mineral industries which are also included in other headings above.
Source: "Survey of Production in Canada", 1941.

This book is concerned fundamentally with explaining the above tables.

It tries to set forth the reasons why the figures for the numbers of gainfully employed and the data for net production by industries differ from one Region to another within Canada. Obviously, many factors influence this regional specialization and

each chapter will elaborate on the forces which localize the various economic activities in the Region concerned. There are, however, three factors—climate, soil, and geology—which are of such basic importance that a few features of general significance regarding them will be considered here. The details will be dealt with later.

Climate

A brief discussion of the climate of Canada is difficult. The discussion may easily be so overloaded with statistics and other details that it becomes wearisome. On the other hand, it may be couched in such vague generalizations as to be meaningless. A description without reasons would be worthless; a full explanation of the underlying factors voluminous.

The variety of conditions to be explained is great. At Surf Inlet on the British Columbia coast near the fifty-fourth parallel the average annual precipitation is 185 inches; at Clinton, 325 miles to the southeast, it is less than 6 inches. At Glacier, British Columbia, the snowfall averages 415 inches or about 35 feet per annum; at Victoria snow rarely falls and never stays on the ground for more than a few days. The lowest temperature ever officially recorded in Canada was 79 degrees below zero Fahrenheit at Good Hope on the lower Mackenzie River but the districts around the city of Vancouver, Vancouver Island and the Queen Charlotte Islands have rarely experienced zero temperatures. At least three towns—Griffin Lake, British Columbia, Cannington and Manor, Saskatchewan—have officially reported maximum temperatures of 110 degrees Fahrenheit. The variations in climate from one part of the country to another are so great that no explanation can be brief and at the same time completely accurate. In this chapter only the general principles will be dealt with. A more detailed description will be given in the chapters covering each Region.

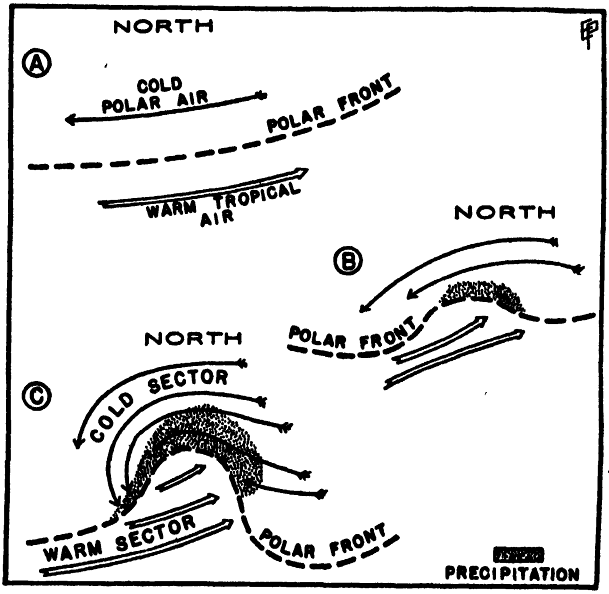
In this introductory discussion, an understanding of some of the elementary facts in climatology will be taken for granted.[10] It will be assumed too that the reader is familiar with the fact that the inclination of the axis of the earth at an angle of 23½ degrees to the plane of its orbit gives seasonal changes in temperature, in length of daylight, and in the elevation of the sun above the horizon. It will also be assumed that the reader knows that average annual temperatures generally decline with higher altitude, that is, as one goes up a mountain side, and with high latitude, i.e., as one goes poleward. Finally, it is expected that the reader knows something of the main wind systems of the planet. At the equator the air is warmed and rises. From a broad belt on either side of the equator, the trade-winds blow in to take its place. When the rising equatorial winds reach altitudes of several hundred feet, they spread poleward. Some of this air mass comes down to the surface of the earth in the horse latitudes located at roughly 20 degrees north and south of the equator. The downward current of air in the horse latitudes spreads northward and southward along the surface of the earth. The remainder of the equatorial air remains at high altitudes until it practically reaches the poles. Meanwhile, the air at the poles has become cold and tends to sink to the surface of the earth. As it does so, it spreads along the ground and, after being

[10]Blair, T. A., *Climatology* (New York: Prentice-Hall, Inc., 1942); Connor, A. J., *The Climate of Manitoba* (Winnipeg: Manitoba Economic Survey Board, 1938); Kendrew, W. G., *Climate* (Oxford: The Clarendon Press, 1930); Koeppe, C. E., *The Canadian Climate* (Bloomington, Ill.: McKnight & McKnight, 1931); Rossby, C. G., "The Scientific Basis of Modern Meteorology", *U.S. Yearbook of Agriculture 1941*, pp. 599-655; Stupart, Sir F., "Factors Which Control Canadian Weather", *Canada Year Book, 1925*, pp. 36-40; "The Climate of Canada", *ibid.*, 1929, pp. 42-51; Trewartha, G. T., *An Introduction to Weather and Climate* (New York: McGraw-Hill Book Company, 1938); Ward, R. DeC., *The Climate of the United States*, Boston, 1925; Klimm, L. E., Starkey, O. P. and Hall, N. F. *Introductory Economic Geography* (New York: Harcourt Brace & Co., 1940); "Meteorology Related to the Science of Aviation", *Canada Year Book, 1943-44*, pp. 24-9.

slightly warmed as it moves equatorward, it sooner or later meets the mass of warmer air moving poleward along the earth's surface from the horse latitudes. The line along which these masses of air meet is known as the polar front.

This front is not static but shifts north and south from time to time. In summer it tends to be farther poleward than in winter. This is partly due to the apparent movement of the sun northward bringing the belts of winds—doldrums, trades, horse latitudes, and so on—northward with it. Besides, the land mass in the interior of the continent heats up more rapidly than the oceans in the same latitude. Water reflects more of the heat that strikes it from the sun than does the land. It is constantly being mixed and overturned by waves, currents, and upwellings so that it is heated, or cooled, more thoroughly and hence more slowly than the land. Water has a higher specific heat than land. More calories are needed to raise the temperature of, say, one cubic centimeter of water five degrees than to heat the same volume of earth by the same amount. Because of the "lag" in the heating and cooling of water in comparison with land, winds blowing onto the land from across large bodies of water are likely to be cooler than the adjacent land in summer and warmer in winter. Typically the presence of oceans and large lakes moderates the temperatures of the land masses. In most of North America the prevailing winds are the westerlies. The Atlantic has only a minor effect on the ruling temperatures of the continent as a whole because it is to the leeward of the land. The tempering influence of the Pacific is minimized by the existence of a mountain barrier which is high, broad, and close to the Pacific coast. Consequently the interior has a greater range of temperature than it would have if the continent were more open to the moderating effect of the prevailing westerlies off the Pacific. For these reasons the southern air mass tends to dominate all the settled parts of Canada during the summer.

In the winter the polar and southerly air masses struggle for control. For reasons not yet clearly explained the polar air mass which seems to originate in the vicinity of the Beaufort sea near the mouth of the Mackenzie varies in strength from one year to another. In the Prairies some winters are abnormally cold because all that Region is rather steadily under the influence of air masses of polar origin drifting over the continent. Other winters



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are relatively mild and cold waves come only occasionally. In these years the polar masses are confined to the far northwest or the far northeast parts of the continent or both, and the warmer southerly mass generally controls the winter weather. At Winnipeg in the course of a century 58 Januaries were exceptionally cold, 24 were much milder than average, 6 were normal

and 12 were variable. An average January in Winnipeg is by far the least likely of all Januaries to occur. The shifting of the polar front makes almost every winter on the Prairies unusual.

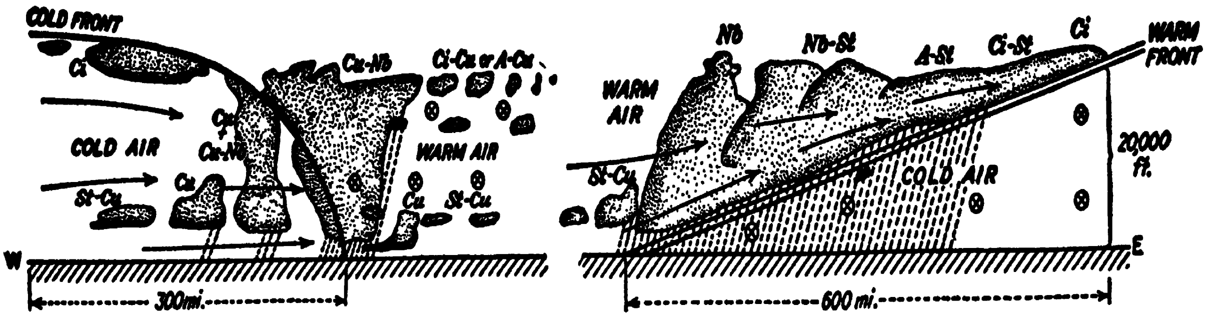
Not only does the polar front shift north and south across the Prairies from one season to another and from year to year, it also rarely appears as a straight line. Instead it is wavy, a "line of sinuosity" in the jargon of the climatologists. The polar and southerly air masses do not push against each other with equal pressure at all points along the polar front. A mass of polar air blowing generally from the north or northeast comes in contact along the polar front with warmer air blowing probably from the southwest. The friction along the line of contact would be sufficient in itself to give rise to an unstable condition. A bulge develops in the front. The bulge gradually grows deeper and a cold segment of air is drawn in behind a warm sector. The polar front is thus broken down into several disconnected parts. Bulges of warm air are interspersed with tongues of polar air.

As the bulge of warm air comes in contact with the cold polar air it is forced to rise, because cold air is heavier than warm. As the warm air rises, it expands due to the lessened pressure of the shallower thickness of air above it. When it expands it uses up energy (heat) and is cooled. Now at any given temperature, air will hold only so much water in its gaseous form (water vapour) as distinct from water in its liquid form (water) or its solid form (ice or snow). As the temperature of the air declines, its capacity to hold water vapour is reduced. At some point or other, depending on how much water vapour the air had initially, the temperature of the air falls to a degree that it cannot hold the water vapour it originally contained. It becomes supersaturated with water vapour. So it must give up the excess, which falls to the ground as rain, or, if the temperature of the layers of air underneath is low enough, as snow. Hence precipitation is likely to occur chiefly along the eastern side of the bulge,

for the warmer air mass blowing from the southwest will exert more pressure there than on the opposite side of the bulge. The eastern segment of the bulge is called the warm front because as an observer crosses this line from east to west (or as it moves past him if he is stationary), there is a change to warmer conditions. Normally the angle of the slope along which the warm air moves above the colder, heavier mass below is very gentle. Rain may therefore occur over a wide area and for two or three days at a time. The warm, gently rising air is not under any great pressure and is commonly called a low pressure air, a "low", or a cyclone. Winds tend to blow inward toward the centre of the low and as they do they are deflected toward the right of the observer who stands with his back to the wind. The cause of this deflection—called Ferrel's Law—is too complicated to be explained here. At all events, winds in the "low" acquire a counter-clockwise rotation.

Meanwhile, the tongue of polar air which has penetrated into the southerly air mass has been pulled along by the winds in the upper atmosphere which are westerlies. The tongue is composed of cold air under considerable pressure and hence is called a "high". Winds tend to blow outward from the centre of this high and, in accordance with Ferrel's Law, they gradually begin to rotate clockwise, forming an anticyclone. Incidentally, the use of the word "cyclone" is not to be confused with the rotary storms, properly called tornadoes, of small area and extreme violence occurring in the interior of the United States. To the meteorologist a cyclone is a large, gently rotating tongue of warm air between two "highs" or anticyclones along the polar front.

Along the northwest or western side of the cyclone there is a line of contact between the warm and the cold air. This line is called the cold front because the observer who is going westward, or who stands in one position and is overtaken by the air masses moving toward him from the west, experiences a change



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Pub. by Harcourt, Brace and Co., Inc., New York

from warm to cold air. The slope of the line of contact between the warm and the cold air along the cold front is likely to be quite steep because the heavy cold air pressing in from the northwest or west cannot rise above the warm air in front of it. In fact, due to friction between the air and the earth and the inability of the cold air to rise above the obstacles, the cold front near the surface of the ground moves slowly but the upper layers of cold air are more free to move at high speed. A wave of water rolling on a beach finds that the speed of its lower parts is retarded by friction while the upper parts still have considerable speed and momentum. Hence the upper parts break or roll over the lower ones. In the same way the cold air overturns into the warmer air ahead of it along the cold front. As a result, the cold front is likely to experience changeable temperatures and variable winds and is sometimes called the squall line.

The area of land covered by a single cyclonic storm varies considerably. Typically the anticyclone has a diameter of from 300 to 1,000 miles. The cyclonic or low pressure area may be even broader. The storms are most prominent in winter, for in summer the air rising from the rapidly heated land mass of the interior of North America tends to nullify their influence. The storms move across the continent from west to east because they are carried along by the prevailing westerly winds in the upper atmosphere. The rate of movement is from 500 to 600 miles a day. This is about the speed of a railway passenger train, so that a person who leaves Vancouver may expect to experience the same type of weather all the way across the continent or, at least, as far as Winnipeg. In their transcontinental course the storms tend to follow certain definite paths. Many storms seem to originate in central Alberta and then are driven easterly, swinging south of the upper Great Lakes and thence up the St. Lawrence Valley.

To recapitulate, masses of polar and warm air meet along

a polar front, the position of which shifts from season to season and from one year to another. Bulges of warm air or "lows" develop along this polar front between two "highs". The lines of contact between the warm air bulge and the polar tongue are known as the warm front and the cold front or squall line. Winds blow into the warm bulge or low in a counter-clockwise direction (a cyclone) and they blow outward from the centre of the highs in a clockwise manner (an anticyclone). Along the warm front the winds at the surface of the earth are likely to come from the south, southeast or east. There will be gentle rains or snow which may last for two or three days. At any given point precipitation may occur while cool air is still present at the surface of the ground there due to the rising, expansion and cooling of the warm, moisture-bearing air ascending at a gentle slope above the cool air. Thus, rains may occur in advance of the warm front. In two or three days the rains will cease and the region concerned will experience rising temperatures for a day or so until the cold front reaches it. It may then have a little rain along with squalls or winds of variable direction and rates of speed. Then the weather will become clear and cool as the polar air tongue takes command of the weather. It cannot be emphasized too strongly, however, that the standard or normal pattern of a cyclonic storm rarely occurs in the simple manner just described. There are an infinite number of variations from the typical storm.

It should be apparent from the above that the cyclonic storms are important factors in determining the day-to-day weather in Canada. It should be clear too that struggle for dominance between polar and southern air masses chiefly explains why Canadian winters are almost always unusual, either colder or warmer than average. It must be reiterated that climatology is a complicated subject and only the barest outline of the chief factors determining the climate of Canada can be given here.

A word or two should probably be added regarding the influence of the Pacific Ocean. An earlier view of Canadian climate stated that the westerly winds blowing across the warm waters of the Pacific Ocean absorbed moisture. When the winds struck the sides of the mountains along the coast they were forced to rise and cool and hence drop their moisture. When these winds reached the Prairies they had been "wrung dry": they had no precipitation to give to the Plains which suffered from deficiency in rainfall. Eastern Canada, so it was thought, got its rainfall partly from the westerlies which picked up some moisture from the land over which they blew, and partly from the easterly winds blowing off the Atlantic.

This so-called explanation was partially correct in so far as it related to the Pacific coast as will be explained more fully in connection with that Region, but the older explanation is at fault in dealing with the Plains. After having passed the Cordillera the Pacific air cannot descend into the dense, dry, cold air of the Prairies but must continue to ride aloft. If it attempts to descend, it will gain heat by compression from the overlying masses of air and so will be forced to ascend again. Pacific air could descend only if the Prairies were a vacuum but in fact they are already occupied by polar air which is denser than Pacific air. It is only when this polar air is removed by the cyclonic storms moving eastward and when, for some reason, the pressure of the polar air mass is weak, that Pacific air has much of an effect. This sometimes occurs in winter when winds blow down the eastern slopes of the Rockies from a high pressure area in the interior plateau of British Columbia to a low pressure one upon the Plains. As the winds flow down to lower elevations they are warmed. Sometimes they blow gently for a few days; sometimes they blow relatively swiftly for a few hours. These are the famous Chinooks which intermittently bring mild weather to southern Alberta. As a general rule the Pacific air

cannot reach the lower altitudes on the Prairies and the weather there is chiefly determined by the struggle of polar and southern air masses along the polar front.

Under these circumstances it is obvious that most of the precipitation on the Prairies comes not from the Pacific but from the Gulf of Mexico and the south Atlantic. In summer some of the Prairie rain is of local origin. Water is evaporated from the land by the local bodies of air which may rise due to heating above the land mass, then cool and drop their moisture. Such a phenomenon is likely to take place suddenly and the rain will fall in a thunderstorm. In eastern Canada the same conditions hold as in the west but the southerly air masses bring in more moisture since, on the whole, they have a shorter distance to travel. Except along the coast, the prevailing westerlies blowing across the Pacific have but a minor influence on precipitation. The westerly winds are important chiefly because they carry along the cyclonic storms from west to east across the settled parts of Canada.

Soils

The economic geographer is concerned with soils because they are the source of most of our food. With the exception of sea foods, salt, and water, our diet is composed entirely of plants and their seeds or of meat and other articles which are derived, through animals and birds, from the vegetable kingdom. All plants grow in soils and man has always recognized the intimate connection between soils, or land, and his own well-being. Experiments with growing plants in water by supplying the necessary minerals to the water are of little practical importance though they have revolutionary implications.

The growth of a plant is frequently compared to the operation of a factory. A plant uses raw material derived from the air (carbon dioxide) and from the soils. The power for the factory

is supplied by sunlight. Operations can be carried on only when the temperatures are suitable. The immediate product is solid material, chiefly sugar, which goes into the leaves, stalk and roots of the plant. The ultimate product is seeds by means of which the plant regenerates itself. The most important by-product of the "factory" is oxygen which is given off into the atmosphere for use by man and other animals.

Of course the functioning of a plant is not nearly as simple as our crude illustration infers. Indeed the operations are exceedingly complex.[11]

For example, if the temperature falls to freezing or below, most plants are killed because the formation of ice crystals disrupts the material within the cells. At temperatures between freezing and about 40 degrees the plant will not function but lies dormant. At temperatures above 40 degrees most plants will grow if other conditions are suitable. The exact temperature at which growth begins or death occurs varies from one species to another and from time to time. In summer when the sap is thin, a sudden drop in temperature nearly to freezing may destroy the plant, whereas later in the year when the sap in the cells has thickened, a similar drop may not be disastrous. Plants go through physiological changes which fortify them against changes in temperature.

Similarly, plants vary in their needs for sunlight. Oats and hay will thrive in cloudy weather if other conditions are right, while corn must have ample sunshine. The effect of temperature and sunshine on vegetable growth is important in Canada. Many commercial crops, like peaches, are raised under relatively unfavourable climatic conditions although others such as flax grow better in parts of Canada than elsewhere in North America.

[11]Hildreth, A.C., Magness, J. R., and Mitchell, J. W., "Effects of Climatic Factors on Growing Plants", *U.S. Yearbook of Agriculture, 1941*, pp. 292-307; Jarvis, T. D., "The Coincidence as a Major Factor in Agriculture". *Scientific Agriculture*, vol. 12, July, 1931, pp. 760-74.

Assuming favourable climatic conditions, a plant can function only if the soil is reasonably fertile.[12] Plants lack oral and digestive organs and so they can assimilate food only if it is already dissolved in water. Rain or melted snow penetrates the soil and dissolves some of the minerals from the small rock particles. It forms a jelly-like substance or colloid which is chemically intricate and chemically active. That is to say, a colloid is a complex of water, minerals and especially organic matter. This complex is constantly undergoing chemical reactions. The rate at which colloids are created varies from one soil to another and, in the same soil, from time to time. The rate depends on the physical, chemical, and bacteriological condition of the soil, and on the climate, the water supply, and the system of cultivation. The roots of the plant absorb the mineral substances like phosphates and nitrogen, and water which cling to the small particles of soil. These substances move through the stalks of the plant to the leaves where some of the water is given off, or transpired, into the air. The remaining water, with the minerals, is left behind to provide for the growth of the plant and the formation of seeds.

An adequate supply of water is absolutely necessary in order to assist in the formation of colloids and to provide the sap which is the largest single element in most green plants. In arid lands plant life has to adjust itself to the lack of water, while in humid regions a superabundant water supply may wash away the plant nutrients contained in the soil so rapidly that vegetal life is handicapped. Temperatures must be suitable to enable the plant to perform its own functions. In addition they must be such that the growth of innumerable small living organisms—bacteria,

[12]Klimm, *op. cit.*, pp. 91-8; Leahey, A., "The Major Soil Zones of Canada", *Trans. Canadian Conservation Association*, 1941, pp. 40-50; "Soils and Men", *U.S. Yearbook of Agriculture, 1938*; Wolfganger, L. A., *The Major Soil Divisions of the United States* (New York: John Wiley & Sons, 1930).

algae, and fungi—in the soil be stimulated. These organisms break down the minerals in the soil particles and in plants which have died in or upon the soil. The micro-organisms convert insoluble inorganic material into soluble form so that they can be absorbed by water into colloids. If the soil is cold, wet, and too acidic, micro-organisms will not thrive. Plant life is then restricted to species adapted to such conditions, but such plants are of no commercial value. Sometimes the decomposition of plants is so slow on account of the unfavourable environment for micro-organic life that a "woody" soil, or peat, is formed.

Soils also should have suitable physical properties. If the soil particles are very fine and closely packed together (as is common in clay) there are few avenues for the penetration of air and water. The growth of bacteria is therefore slow and oxygen cannot permeate the soil to destroy the poisonous wastes which the plant generates. Also, the roots of plants penetrate such compact soils only with difficulty. On the other hand, clay soils prevent the excessive leaching of plant nutriments. In soils with very large particles (such as gravels) the circulation of air and water is rapid. Bacterial action proceeds rapidly but the nutriments may be washed away by circulating water before plants have been able to take full advantage of them. Gravelly soils warm up quickly in the spring but may suffer from drought, while clayey soils, receiving the same precipitation, would have adequate moisture for healthy and vigorous plant growth. If the physical structure of a soil is poor it may be improved by careful ploughing which permits the easier penetration of air and circulation of water. In compact soils the application of natural manure will improve aeration and prevent caking. In sandy soils animal manure will prevent the loss of water. Earthworms also play a part in promoting good soil structure.

Finally, soils must contain adequate mineral nutriments otherwise the colloids which are formed are deficient in one or other

of the elements needed for luxuriant plant life. Plants need a wide variety of foods such as carbon, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron and boron. Virgin soil is likely to contain all these elements and since, generally speaking, the plants die and decay where they have grown, the soil maintains its original fertility. In fact, it may improve due to the constant activity of micro-organisms on the soil particles. Although there is some loss of nutriments due to their leaching by flowing water, in the main there is a balance of nature, a kind of closed circle through which plant foods travel from soil to plant and back to soil.

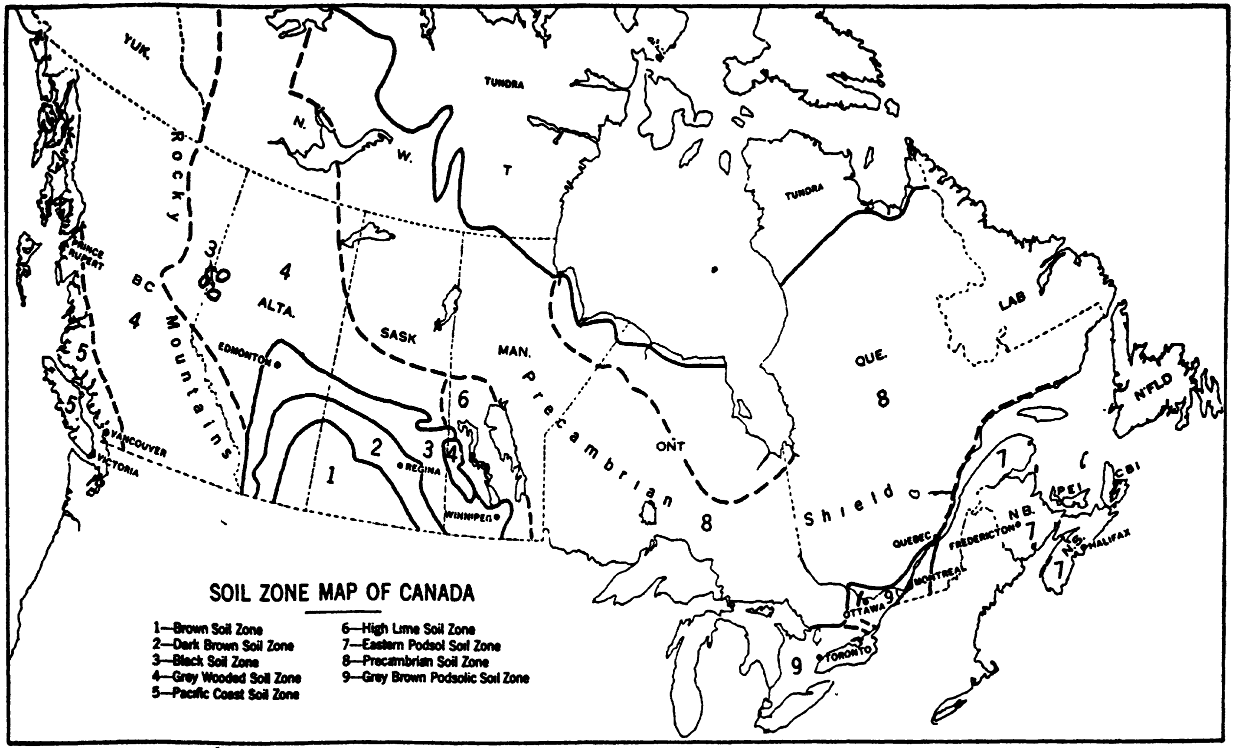
When man begins to grow crops he upsets this natural balance because he cuts down the growing crops and consumes them far from the place where they are grown. In so far as he feeds the crops to animals in the same locality and returns their manure to the fields as fertilizer he reduces the drain of the mineral nutriments. Even so there is a considerable loss. Before long certain of the minerals—particularly calcium, potassium, phosphorous and nitrogen—will become deficient. Unless they are replaced, crop yields will begin to fall off. Also, if calcium and potassium are used up by plants or leached away by water the soils will become too acidic in character and unsuited to healthy plant life.

Soil exhaustion may be offset in a number of different ways. The land may be allowed to lie fallow, that is, uncropped and uncultivated except in so far as working is necessary to keep down weeds. During the fallow period chemical and bacterial activity add to the colloidal material and replenish some of the exhausted elements. A more rapid way of feeding the soil is by applying natural or artificial fertilizers. The former supply almost all the minerals necessary to plant life, improve the tilth of the soil, and stimulate the activity of bacteria on the soil particles. For these reasons they are superior to chemical fertilizers

even though the latter can be mixed in varying proportions of phosphates, nitrates and potash to provide the precise minerals which are deficient. A further method of retarding soil exhaustion is by means of crop rotations as will be more fully explained later.

All soils are formed by the decomposition of rock. Glaciers grind up rocks into fine powder. Running water wears down rock and carries away fine particles. Water freezes in small cracks and crevasses in the rock and splits it apart. By these and other methods the underlying rock is pulverized into clay, loam, sand and gravel. In young soils, that is, in those which have been recently created, the nature of the underlying rock and the character of detritus transported by glaciers and running water are the principal determinants in the quality of the soil. However, all mature soils, those which have been on the same site for centuries, are more largely the product of climate than they are of the parent rock material. The climate determines the types of microbes present in the soil and the speed at which bacterial action takes place. It also profoundly influences the type of vegetation growing on the maturing soil. While living, the vegetation influences the colloidal activity within the soil. When the plant dies it is attacked by bacteria which create soluble elements for the use of growing plants. The result is that soils are mainly the creatures of their environment. Because the climate of Canada varies from one geographic province to another, the soils can be expected to show similar diversity.

There are four broad soil Regions in Canada. The podsols or forest soils occupy all eastern Canada and the great forested section in western Canada between the treeless Prairies to the south and the tundra to the north. Podsols are created under conditions of fairly high rainfall and relatively low temperature where the typical vegetation is coniferous or hardwood forests. Often podsols are infertile because they have lost many of their valu-



Reproduced, by permission, from "Transactions of the Canadian Conservation Association, 1941"

able minerals by leaching. If the natural drainage is very poor, the soils may become so waterlogged and acidic that peat bogs result. The hard needles of the coniferous trees decompose slowly on account of the low rate of bacterial activity due to the climate. Thus the soils are often deficient in organic matter. They may become grey and ashy in character. Many of these soils are so poor that they are likely to remain permanently in forests. Farther south, in the St. Lawrence Valley and parts of the Acadian-Appalachian Regions, the temperatures are more moderate so that bacterial action is more rapid. The natural forest cover consists of deciduous trees whose leaves decompose more readily than pine or spruce needles. Leaching is typically not so severe. The soils are still podsols but the ashy-grey colour gives way to grey-brown and even to still darker shades. The soils toward the south are easily tilled and make a good response to manures and chemical fertilizers. The climate is more favourable than farther north for the growth of crops of high commercial value and so these grey-brown podsols, though of only moderate fertility intrinsically, form the basis of a prosperous agriculture.

The second chief soil region includes the prairyerths and chernozems which occupy all the wheat-growing sections of the western plains. The distinctive features of these soils are that they have developed in a sub-humid climate and under a cover of grass. The rainfall is so low that the soils have been leached of only their more soluble constituents. In fact, many of the minerals which were originally dissolved by water from the very top layer or "horizon" of the soil have been carried down to a slightly lower horizon where the water has evaporated, leaving the minerals behind. If the rainfall in the West had been as high as in eastern Canada, the soluble minerals would have long ago been washed away into lakes and rivers by running water.

The precise character of Prairie soils varies with the thickness

of the grass, which is indirectly the result of climate. In addition the climate has had a direct effect on the soils through its influence on micro-organic activity, leaching and so on. In the southern Prairies where the rainfall is slight, the soils are light brown but as the native vegetal cover increases, the soils become darker until they form the black soils of the Park Belt. Some of the chernozems (Russian for black earth) of the West are among the world's best soils from the point of view of intrinsic quality, and the brown earths are only slightly inferior. These soils require little fertilizer, are easily tilled, are rarely leached to excess and are not unduly acidic in character. Yet the lack of precipitation and the northern location of the chernozems limits the types of crops which can be grown and thus their commercial value.

The third soil zone comprises the exceptionally complex soils of British Columbia. Along the coast the winters are mild and rainy, while the summers are dry. This is the exact reverse of the climate on the Prairies. The native vegetation was magnificent forest rather than grass. The high rainfall leaches away the nutriments very quickly and some of the soils are low in organic matter. The climate is favourable for the activity of micro-organisms and so the soils, instead of being ashy like the leached podsols, are often reddish or yellowish-brown in colour. Actually, most of the farming in the Fraser River valley is conducted on the flood plains and deltas where the soils are so young that they do not bear the imprint of the typical climate and vegetation of the Region. In the fruit-growing and grazing districts of the interior the rainfall is low and the original cover was grass. Hence the soils are usually light brown, similar in general character to those of the Prairies. Large sections of the Pacific Region are mountainous and entirely lacking in soil cover.

The final soil Region is the tundra. Here much of the soil is water-logged during the short summer and all of it is frozen

to great depths during the winter. The environment is not favourable to the activity of microbes in the soil. The soils deter vegetation, aside altogether from climatic limitations on plant growth.

It should, perhaps, be reiterated that the science of soils is an exceedingly complicated one. It should be emphasized too that soils vary considerably from one small district to another even within the same soil zone. In any brief summary of the significance of soils on economic activity, only statements of general applicability can be made.

Geology

Although some professional geographers use the geology of a Region as the key to its subsequent development,[13] most economic geographers are content to incorporate into their science only so much of the study of geology as will enlighten the student of the earth and man's use of it for the purpose of making a living. The economic geographer is usually concerned with geology only to the extent that it helps to explain why certain economic activities are carried on in particular Regions. It is obvious that geology is important in determining whether or not a Region can carry on mining, generate hydro-electric power, sustain agriculture, and so on.

The influence of geology cannot be thoroughly understood without knowing the geological history of a Region. This involves a knowledge of a highly specialized science.[14] In a book of

[13]Taylor, G., "Structure and Settlement in Canada", *Canadian Banker*, vol. 48, October, 1940, pp. 42-65; "Fundamental Factors in Canadian Geography", *Canadian Geographical Journal*, vol. 12, March, 1936, pp. 161-71; *Environment, Race and Migration* (Toronto: University of Toronto Press, 1937), pp. 277-360.

[14]Atwood, *op. cit., passim*; Chamberlain, T. C. and Salisbury, R. D. *College Textbook of Geology* (New York: Henry Holt & Co., Inc., 1930); Finch, V. C. and Trewartha, G. T., *Elements of Geography* (New York: McGraw-Hill Book Company, 1936); Hinds, N. E. A., *Geomorphology, the*

(Continued on next page)

this nature it is clearly impossible to describe in detail what has occurred over eons of geological time, let alone explain the processes which have brought about these changes. Moreover, professional geologists are by no means agreed on the history, especially in the more remote eras. Hence, it seemed logical to give only the barest outline of the geological history of the various Regions in Canada before the last Ice Age and to omit almost entirely consideration of the agencies such as running water, waves, and vulcanism which brought about these changes. At the same time, some discussion of the work of moving ice seemed to be called for because of the marked effect which continental and mountain glaciers have had on the topography and economic development of Canada. Also, the glaciers existed so recently, geologically speaking, that scholars are in more complete accord on their effects than they are on the details or even on the main features of the earlier eras.

The general picture of the geology of Canada is relatively simple. The oldest rocks now exposed at or near the surface anywhere in the Dominion are those of the Canadian Shield. Since these formations contain almost no evidence of plant or animal life, they are known as Archeozoic (primordial life). As soon as these rocks were elevated above the sea they began to be worn down by rains and running water. These forces of erosion worked exceedingly slowly but over the course of literally millions of years the Shield was reduced almost to a level surface or peneplane. Meanwhile the detritus which had been washed down had been accumulating in layers or strata in the adjacent

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Evolution of Landscapes (New York: Prentice-Hall, Inc., 1943); Lobeck, A. E., *Geomorphology, an Introduction to the Study of Landscapes* (New York: McGraw-Hill Book Company, 1939); Longwell, C. R., Knoff, A., Flint, R. F., Schuchert, C., and Dunbar, A. S., *Outlines of Geology* (New York: John Wiley & Sons, 1941); Shimer, H. W., *An Introduction to Earth History* (Boston: Ginn & Company, 1925); Seeman, A. L., *Physical Geography* (New York: Prentice-Hall, 1942).

seas. Along the southeastern shoulder of the Shield these strata were later elevated into a series of mountain ranges trending southwest to northeast. Over the centuries these mountains in their turn were eroded and, after many vicissitudes including modification by the Pleistocene glaciers, they formed the present Acadian-Appalachian highlands.

Far to the westward between the Shield and the present Pacific coast more detritus was deposited partly from the Shield and partly from another ancient land mass, Cascadia, which is believed to have occupied the interior of modern British Columbia. This detritus was also uplifted into mountains, chiefly along the present coast, to the accompaniment of volcanic activity and the intrusion of enormous quantities of lava between the layers of rock. The mountains, of which the Coast Range is the modern remnant, were heavily eroded chiefly by running water. On the eastern flank of the Coast Range, the great Rocky Mountains were uplifted in comparatively recent times. The strata between the Rockies and the Shield have been relatively undisturbed since their formation but the upper ends of the rocks which mantled the Shield in southern Ontario have been worn away by geological processes. The stratified rocks of the Arctic Archipelago have had a relatively placid existence since their deposition.

A few of the more important details of the geology of each Region will be dealt with in the chapter assigned to each. The layman is referred to a few elementary texts[15] and the expert to the numerous publications of the Geological Survey of Canada.

[15]Coleman, A. P. and Parks, W. A., *Elementary Geology, with Special Reference to Canada* (Toronto: J. M. Dent & Sons (Canada) Limited, 1922); Malcolm, W., "The Geology of Canada", *Canada Year Book, 1936*, Ottawa, pp. 18-28; Young, G. A., *Geology and Economic Minerals of Canada* (Ottawa, King's Printer, 1926).

CHAPTER II

ACADIAN-APPALACHIAN REGION

THE ACADIAN-APPALACHIAN Region includes all Canada east of a line running northeast from the foot of Lake Champlain to Quebec City. It therefore comprises all the provinces of Nova Scotia, New Brunswick, Prince Edward Island and the Gaspé Peninsula and the Eastern Townships in the Province of Quebec. Altogether it consists of about 70,000 square miles and is a little larger than the New England states to which it has close geological and economic similarities.

Topography

The most conspicuous feature of the landscape[1] of this Region is the presence of parallel bands of hard rock trending southwest to northeast. The Quebec section is basically an extension of the Appalachian mountain system of the United States with its low parallel ranges and intervening valleys. When they enter Canada in the Eastern Townships the three ranges of the Appalachians have elevations approaching 3,000 feet above sea level. The easternmost range forms part of the International Boundary and then passes into the State of Maine while the central one loses its identity toward the northeast. The western range, after sinking in elevation as it approaches the Chaudière River, rises again to maximum heights of 4,200 feet in Gaspé. Because these ranges are much dissected by rivers, high altitudes are unusual and the

[1]Atwood, W. W., *The Physiographic Provinces of North America* (Boston: Ginn & Company, 1940), pp. 65-106; *New Brunswick* (Ottawa: Dept. of Interior, 1930); *Nova Scotia* (Ottawa: Dept. of Interior, 1930); Brouillette, B., *La Région des Appalaches*, in Minville, E., *ed.*, *Nôtre Milieu* (Montreal: Éditions Fides, 1942), pp. 79-87.

general appearance of the district is not mountainous but hilly. A hilly country can be defined as one in which the land has a considerable degree of slope, with uplands of small summit area and with local relief (unevenness of land surface) of more than 500 and less than 2,000 feet. The Appalachian hills merge into the St. Lawrence Lowland Region to the west. Along the Gaspé Peninsula, the St. Lawrence River so closely approaches the highlands that there is almost no level land along the coast. Toward the southeast the Appalachian sub-region blends into the Acadian section.

In the Acadian sub-region, northwestern New Brunswick is a plateau about 1,000 feet above sea level. In the central part of this province there is a very gentle downfold heavily dissected by the St. John River and its tributaries which have cut deep channels or trenches into the softer rocks. Toward the east the terrain becomes more broken and, at the same time, more elevated, with many rounded hills and ridges rising to heights of 2,500 feet above sea level. Beyond this is a lowland of about 600 feet elevation which begins as a narrow strip along the Gulf of St. Lawrence, then broadens out along the Straits of Northumberland and finally extends to include the "North Shore" of Nova Scotia along the Straits. Prince Edward Island is essentially another segment of the same plain. In the southern part of New Brunswick a series of hard rocky ridges parallel the Bay of Fundy.

In Nova Scotia an upland extends southwest to northeast throughout the entire length of the province. This upland, the topographic "backbone" of Nova Scotia, rises from the broken, indented Atlantic seaboard to broad summits 600 to 1,000 feet above sea level. It fades gradually into the lowland along the north shore. Along the Bay of Fundy it is flanked by a relatively low, narrow ridge with the fertile Annapolis-Cornwallis valley in the trough between. Cape Breton Island is a continuation of the main Nova Scotia upland but is divided into a

series of isolated ridges and plateaus some of which rise steeply on all sides to heights of 1,500 feet, whereas the main upland is more hilly and broadly rolling.

Geology

As already explained, the Shield constitutes the geologic core of modern Canada.[2] Along its edges thick layers of detritus were laid down in early geologic time and later this material was uplifted into mountains and then slowly eroded by running water. The mountain-building forces crumpled the strata into close folds, left them in broad open troughs, lifted parts of one strata above adjoining parts of the same strata in a more or less vertical plane (creating what is technically called a fault) or else slid one layer over another horizontally forming a thrust. At one time igneous material intruded between layers of rock. Because this molten mass cooled off slowly, large crystals of feldspar, quartz, and mica were formed, producing the granite which constitutes most of the "backbone" of Nova Scotia. In other districts and in other eras limestone, gypsum, salt, and coal were formed. Thick beds of reddish conglomerate, sandstone, and shale were deposited along the Minas basin and southwest along the present Annapolis Valley and sandstone was laid down in Prince Edward Island.

Erosive forces operated on these formations throughout eons of time. By the end of the Mesozoic era the various hilly and upland surfaces which we can observe in the landscape to-day were, in general, created. In the Gaspé Peninsula an ancient mountain range has been so worn down by erosion and so faulted and folded by forces of gigantic strength that it now appears as a series of hard rocks parallel to each other and trending northeast. In central New Brunswick there is a broad downfold or geosyncline, while in the southern part of this

[2] Atwood, *op. cit.*; Young, *op. cit.*

province and in Nova Scotia the remnant of another mountain range constitute the basic feature of the build of the area.

During the Pleistocene period or Ice Age all the Acadian-Appalachian Region except a few isolated peaks in Gaspé was covered by the immense glacier which occupied all of Eastern Canada. In addition there were smaller glaciers of local origin in Nova Scotia. This vast thick mass of ice had a less pronounced effect on the topography than is commonly supposed. The Region had already been heavily eroded by water and the glacial ice did not erase the rock base of the Region to any great depth. Nevertheless, the ice-sheet put a stop to the work of running water; it scoured off and carried away the soil and partially decayed rock from the surface of the land; it wore down the hills of hard rock to some extent, especially on the side facing the moving ice; and finally the glacier deepened and widened the pre-existing river valleys. Where the rock was soft, the advancing glacier gouged out holes and when the ice had disappeared these depressions were wholly or partly filled with water to form lakes, ponds, and swamps.

The moving ice carried along with it considerable amounts of soil, gravel and boulders. Some of this material it dropped under fissures in the ice lobe to form elliptical hills called drumlins such as those near Yarmouth, Halifax, Mahone and St. Peter's bays. Since the detritus so deposited by the glacier has not been worked over and sorted into various sizes by moving water, drumlins consist of unstratified material. Typically they have their longer axes parallel to the direction of ice motion and their larger and higher ends at the northwest toward the point of origin. At times streams flowing beneath or in fissures between the ice laid down stratified material in the shape of either ridges called eskers or conical hills known as kames. Both these formations are common in southern New Brunswick.

As the glaciers melted and retreated, they dropped haphazardly

over the surface of the underlying rock the material which they had not already left in drumlins, eskers, and kames. Consequently the base rocks of most of the Region were left with a thin cover or mantle of glacial drift. Sometimes material dammed up the channels of the pre-existing rivers, forcing the post-glacial streams to seek new courses. Where these rivers encountered hard rock ledges they developed falls and rapids. If given sufficient time, the rivers will wear down the ledges and create relatively placid courses for themselves but despite the millions of years which have elapsed since the Ice Age, few streams have been able to erode smooth channels.

When the ice-cap disappeared the land stood lower than it does now. This is shown by the beaches which must have been formed subsequent to the glaciation and which are now located at heights several hundred feet above present sea level. Later the area sank, particularly along the Atlantic coast, permitting the sea to enter the valleys and form the bays of the present indented coast. Hills and mountains near the river mouths were partially submerged, to form islands off shore. Thus the Acadian-Appalachian Region finally attained substantially its present form.

The work of geological agencies operating on the Region did not cease with the retreat of the ice but is continuing to-day as in past generations. The rivers are slowly bringing down glacial drift and wearing down the rocks. Water, frost, and growing plants break down the rocks. All these agencies are so slow in their operation that their effects are scarcely noticeable in any one man's lifetime. Even in the millions of years which have elapsed since the retreat of the ice, the agencies of erosion have been able to make but little impression on the hard Paleozoic rocks of the uplands but they have been able to weather down the less resistant sandstones and shales of the Annapolis Valley, Prince Edward Island, the North Shore and the New Brunswick

lowland, Victoria and Carleton counties near the headwaters of the St. John River, the valleys of the Eastern Townships and isolated patches elsewhere.

The ponds and lakes lying in depressions torn out of the rock by the ice-sheet or dammed up by glacial moraine are being drained as the rivers wear deeper channels into the rock. In other cases the depressions are being filled up by silt brought down by streams or by the decay of vegetation growing along the banks and in shallow water. In these ways, over the centuries since the last diastrophic movements and climatic changes, soil of varying degrees of fertility has been created.

While these changes have been occurring on land, other agencies have been creating new topographic forms along the sea coast. Waves are everlastingly re-arranging into spits, bars and other coastal formations the loose material brought down by streams. Where the beaches are narrow and nothing interferes with their action, the waves can attack the rocks along the shore directly. In cases where the rocks are composed of strata of different degrees of hardness, curious formations may result like those on Grand Manan Island in the Bay of Fundy or Roc Percé off the Gaspé coast. Exceptionally high tides along the Bay of Fundy have gathered up silt from near the mouths of rivers and deposited it in Minas Basin and at the head of Chignecto Bay to form fertile marshes which have since been reclaimed from the sea.

The general picture of the topography of the Acadian-Appalachian Region to-day is one of glaciated hard, crystalline rocks of no great altitude, typically occurring in rounded hills and plateaus, the general trend or "grain" of the Region being southwest to northeast. In a few areas of softer rock, weathering has created fairly continuous stretches of fertile soil. On the uplands soil is either entirely absent or consists of a thin mantle of glacial drift. Along the rivers, with the possible exception

of the St. John, and in the Eastern Townships, the fertile soil occurs only in patches because the surrounding rocks are very resistant to erosion and the rivers typically short, of relatively low gradient and therefore of little erosive power. The deposits of coal, asbestos, gypsum, salt, and building stone are of considerable economic importance. The sunken coast-line provides fine harbours at Halifax and elsewhere and the submerged plateau off the coast constitutes excellent fishing grounds. The geology of the Region in conjunction with the climate determines the broad basis of economic life.

Climate

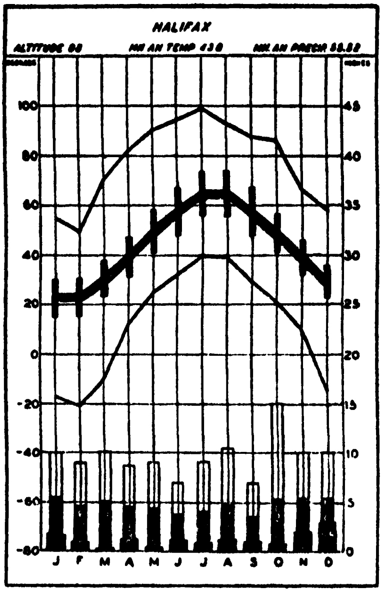
Like other parts of settled Canada the Acadian-Appalachian Region[8] is under the influence of the prevailing westerlies and the cyclonic storms. Because the winds generally blow from the interior of the continent, the Region is not as much affected by the Atlantic Ocean as one would expect from the fact that it is surrounded on three sides by salt water. Yet, at times the moderating influence of the Atlantic and the Gulf Stream is carried many miles inland by occasional south or southwest winds.

The Region has a greater range of temperature than coastal British Columbia and Great Britain which, though farther north, are persistently under the influence of westerly winds blowing from broad oceans. In comparison with areas immediately toward the westward this Region has a more moderate type of climate. This is because it is somewhat removed from the interior of the continent where the land becomes very heated in summer and very cold in winter.

Mean January temperatures in Nova Scotia are from 20 to 24 degrees Fahrenheit, or about 10 degrees higher than at Montreal.

[8]Stupart, Sir F., "Factors which Control Canadian Weather", *Canada Year Book, 1925*, pp. 36-40; Koeppe, *op. cit.*, pp. 170-99; Putnam, D. F., "The Climate of the Maritime Provinces", *Canadian Geographical Journal*, vol. 21, September, 1940, pp. 135-48.

Spring is delayed in Nova Scotia due to the cooling influence of the surrounding water. The summers are rarely hot. Temperatures above 90 degrees are unusual and occasionally, when the winds blow from the northeast, the summer days are disagreeably cool. Only July and August have average temperatures above 60 degrees but the autumn is long. As a rule the first frosts do not



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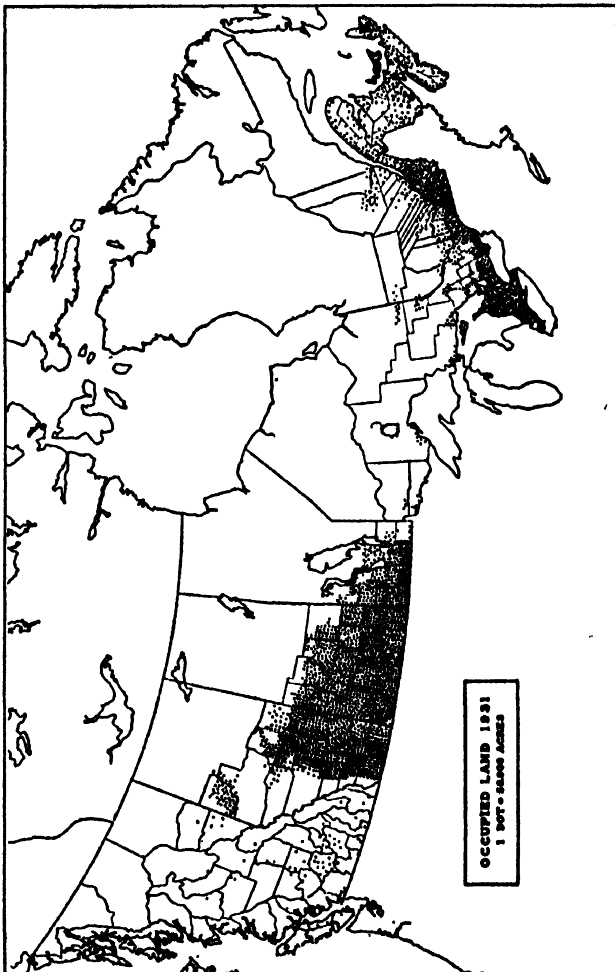
In this graph and others of the same type in the book, temperatures are to be read on the left-hand scale. The topmost curve shows the highest temperature ever recorded at this station. The heavy curve gives the mean temperatures and the upright bars across this curve represent the mean daily ranges in temperature. The lowest curve indicates the lowest temperature recorded. Precipitation data are to be read on the right-hand scale. The top of the bars which rise vertically from the base line of the graph show maximum monthly precipitation. The top of the solid black part of each bar gives the average precipitation and the top of the broader part of the solid black section represents the minimum monthly precipitation.

come before the end of September. Winter settles down in November in which month the average temperature is 30 degrees. The frost-free season is about 190 days long in southern Nova Scotia but it decreases slightly as one goes inland and northward.

The influence of the ocean is reduced as one goes westward from Nova Scotia. Prince Edward Island and the littoral of New Brunswick are a little cooler in winter than Nova Scotia. The plateau of New Brunswick and the Appalachian sub-region have Januaries about 20 degrees colder than Nova Scotia due to their greater altitudes and remoteness from the sea. Similarly, in summer, continental influences rather than oceanic ones are more powerful in the interior than on the coast. Spring arrives sooner; maximum summer temperatures are higher; autumn begins earlier. The average frost-free season is as short as 150 days in northern New Brunswick.

The average annual precipitation is about 55 inches at Halifax and between 45 and 50 throughout most of New Brunswick. On the whole, precipitation is evenly distributed throughout the year. Some sections may have heavy snowfalls. In Northern New Brunswick the annual average is about 80 inches. At all points in the Region the rainfall is adequate every year for all the crops which can be grown within the thermal limits.

The number of days on which rain or snow falls ranges from a maximum average of 167 in a year at Halifax to a minimum of 119 in the Annapolis Valley. Thus cloudy days are common. During the summer whenever moisture-bearing winds from the land blow over the relatively cold waters of the sea, they are cooled and form fog over the water close to shore. In the fall, conditions are reversed and fog is created over the land along the shore. In the late summer and winter the differences between the land and sea temperatures are less pronounced and fogs are infrequent. Rarely do fogs extend far inland. All these



Reproduced, by permission, from McArthur and Coke, "Types of Farming in Canada", published in Pub. 653, Dom. Dept. of Agric., 1939

climatic conditions have important effects on the agriculture of the Region.

Agriculture

Agricultural development in the Acadian-Appalachian Region is restricted by climate and soils.[4] The climate limits the number of products which may be grown and the soils determine in what particular district within the Region, these products are to be raised. For the most part the climate is not favourable to the growth of farm products of high quality and the fertile soils occur only in small patches. Therefore farming is of a secondary character for the Region as a whole but there are three or four pockets with climate and soils suitable for the production of valuable agricultural products. Only in these pockets is agriculture profitably carried on.

The first district of profitable agriculture is the Annapolis-Cornwallis valley. It is roughly 80 miles long and from 10 to 15 miles wide. It is drained by the Annapolis River into the Bay of Fundy near Digby and, beyond a low watershed at Middleton, by the Cornwallis River into Minas Basin. The valley is open at both ends and is bordered by even crested hills, locally called mountains, with fairly steep sides rising to heights of about 1,000 feet.

The most important agricultural crop in the valley is apples, the output being one-third to one-half the total Canadian supply. The raising of apples in this district is favoured by geographic

[4]Brouillette, *op. cit.*, pp. 99-102; Dresser, J. A., "The Eastern Townships of Quebec", *Trans. Royal Society of Canada*, vol. 29, section IV, 1935, pp. 89-100; Longley, W. V., "Land Utilization in Nova Scotia", *Journal of Farm Economics*, vol. 18, August, 1936, pp. 533-42; McKibbon, R. R., and Pugsley, L. I., *Soils of the Eastern Townships of Quebec*, Macdonald College, 1930; Putnam, D. F., "Farm Distribution in Nova Scotia", *Economic Geography*, vol. 15, January, 1939, pp. 43-54; "Agricultural Development in New Brunswick", *ibid.*, vol. 15, October, 1939, pp. 408-20.

factors.[5] The mountains tend to give protection from the northwesterly and occasional easterly winds which, either because of their force or their frostiness, might be bad for fruit growing. Proximity to the Bay of Fundy moderates the climate and gives protection against frost. In the spring the relatively cool water nearby delays the opening of the buds until all danger of frost is over. In the fall the water, which is now warm relative to the land, usually postpones the frosts until the harvest has been completed. Thus the district is in a position to take advantage of the fact that water heats up and cools off more slowly than land does. A further benefit from proximity to water is that the very high tides for which the Bay of Fundy is famous, create a movement of air even on otherwise calm nights. This tends to neutralize the effect of frost which is always most serious when the air is still. The tides come into Digby and Minas basins and up the Annapolis River itself.

Although topography tends to offset some of the harmful effects of the climate, other climatic difficulties still remain. Sometimes rains come while the trees are in blossom. This prevents the bees from carrying on their work of cross-pollination and the crop in the autumn is likely to be small. The general dampness and comparative coolness of the weather encourages the growth of fungus and fruit growers have to go to special pains to spray their trees often in order to prevent reduction of yield and quality on this account. The sky is frequently overcast. Accordingly growers have to select those varieties of apples which do not have a high colour. In comparison with British Columbia, where dessert varieties like McIntosh are the most important, Nova Scotia growers raise mainly cooking apples. In general, the topography and climate of the valley are suited to apple

[5]Colby, C. C., "The Apple Industry of the Annapolis-Cornwallis Valley", *Economic Geography*, vol. 1, July 1925, pp. 337-55; Longley, W. V., *Some Economic Aspects of the Apple Industry in Nova Scotia* (Halifax: N.S. Agric. Dept., 1932).

production but farmers have to adapt their cultural practices to counteract the effects of the relatively high humidity and the deficiency of sunshine.

Agriculture in the district is aided considerably by the ease with which it can export its crop to the large market in Great Britain. Formerly tramp steamers picked up the fruit at Digby or at ports in Minas Basin but the competition of these vessels with trans-oceanic services through Halifax forced a reduction in the rates by rail to Halifax and by liner beyond. Now, most of the export apples move through Halifax. Cheapness of transportation has also facilitated the import of fertilizers and spray materials. A minor gain is the low cost of local supplies of wood for making barrels and other shipping containers.

An advantage of great importance is the long experience of the farmers in pomiculture. Apples were first exported in 1881 and have been the most important crop of this district since 1900. Throughout the years the farmers have accumulated a fund of experience and a marketing organization which is just as much an asset of the area as its soil or favourable climate.

Although apples are the main crop of the Annapolis-Cornwallis valley it would be a mistake to think that the farmers raise this product to the exclusion of all others. Indeed, in 1931 the average farm was 165 acres in size and of these 44 acres were in field crops, 20 acres in orchards and the balance in woods, woods and pasture, or pasture alone. Of course, there were wide differences in the size of the farms and in the use of land. Individual orchards ranged in size from four acres to ninety. A few farmers received practically all their revenue from apples but the typical farmer got 60 per cent of his income from apples, the remainder coming chiefly from beef and dairy cattle. The apple growers usually also raised some plums, cherries, and strawberries.

There are two reasons for the diversity of production on the typical Annapolis farm. The first reason is geographical. The

number of good orchard sites is distinctly limited. The best site is one where the soils are sufficiently gravelly to provide good drainage and yet have enough fine materials to retain the requisite amount of water. Even more important than water drainage is the matter of frost drainage—the fact that cool air, being heavy, has a tendency to move down slopes. The orchards on the upper parts of the slopes will not be injured until the lower parts of the valley are, so to speak, filled with cold air. A properly located orchard will entirely escape the light frosts and suffer less severely from the heavy ones. The ideal site is a hill about 50 to 150 feet above the floor of the valley. Many attempts have been made over the years to grow apples on other locations but these have not, generally speaking, been successful in producing large crops of consistently high quality. Since the number of good locations is distinctly limited and since they are surrounded by land which is already cleared and which can be readily used for crops and pasture, it is natural that the farmer should use all the land at his disposal even though his main attention is given to one product.

The second reason for diversification is that the apple grower who raises only that product exposes himself to the vagaries of the market for apples. If the price of apples is depressed, as it is from time to time, the man who has concentrated on apples to the exclusion of other products suffers severely, whereas the man who has used his land for many articles has a greater security. In any event, apple growers in Nova Scotia carry on diversified farming—quite a contrast to the horticulturists of the Okanagan Valley in British Columbia.

The success of apple production in the Annapolis Valley has encouraged the growing of apples in other districts in the Maritimes like parts of the St. John River Valley and Prince Edward Island. These efforts have not generally been successful. The climate elsewhere in the Region is not quite as favourable as it

is in the Annapolis Valley. For example, during the winter of 1933-4 over half the mature apple trees on Prince Edward Island were killed or badly injured by frost.[6] These other districts have the further difficulty of lacking a fund of knowledge similar to that which the people in the Annapolis area have acquired over the last fifty years.

The problems which face the apple growers in this district are those of production and markets.[7] Pruning, fertilizing, spraying in order to keep down the numerous fungus diseases and insect pests, grading and packing are all technical problems which each farmer has to face. The chief market is in Great Britain which normally absorbs about two-thirds of the total annual crop of two million barrels. Smaller quantities are sent to the West Indies and Newfoundland, about one-sixth is sold within Canada and the remainder is used locally in cider or vinegar factories, canneries, and dehydrating plants. In the British market there is keen competition from American, Tasmanian, New Zealand and other apples. Because of the lack of a large local market Nova Scotia is forced to export all grades of fruit including the poorer ones. Even though fruit is purchased by wholesalers abroad only after careful physical inspection, the fact that such of the Maritime fruit on the British market is of second or third grade adversely affects the sales price of the number one grades. Maritime apple growers are apprehensive lest a British tariff militate against the sale of their product. So far this threat has not become an actuality. In fact, Canadian apples enjoy a small preference in the British market but the fear of

[6]Clark, J. A., and Warren, G. C., *Varieties of Tree Fruits for Prince Edward Island* (Dominion Department of Agriculture [hereafter referred to as Dom. Agric. Dept.], 1940).

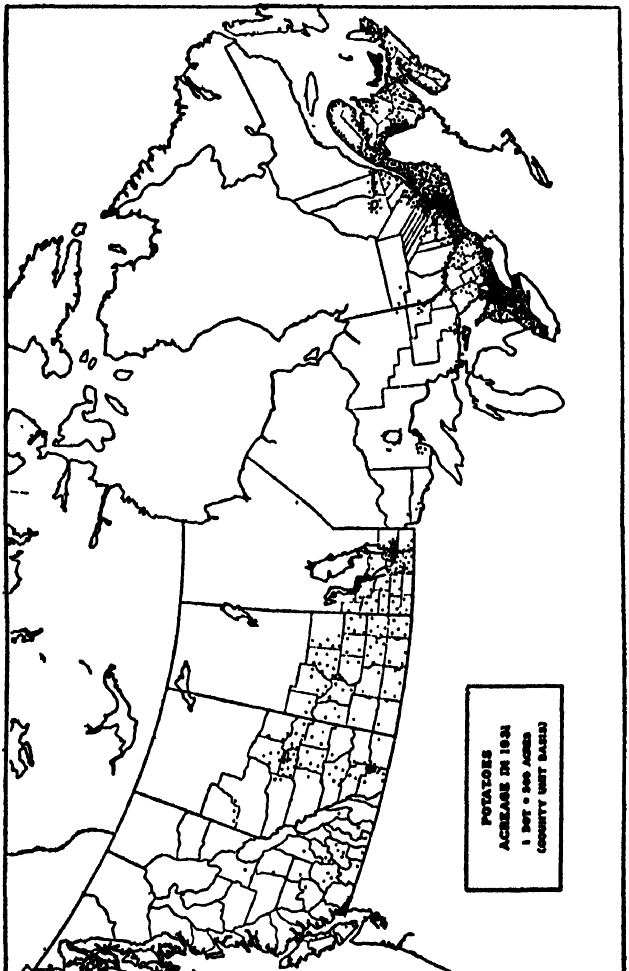
[7]Apple Marketing Committee, *Report* (Halifax: N.S. Agric. Dept., 1927); Groff, C. G., "Apple Marketing in Nova Scotia", *Economic Annalist*, vol. 24, March, 1940, pp. 25-6; Johnson, T. H., "The Fruit Growing Industry of Nova Scotia", *Canadian Chartered Accountant*, vol. 23, November, 1935, pp. 349-53; Longley, *supra.*

adverse tariff action is constantly hanging over the industry. During the second World War the British market was almost completely cut off due to the difficulty of transporting such a bulky commodity as raw apples. Much of the output was canned or dehydrated. Many of the older and less productive trees were cut down and replaced by younger stock which will come into bearing after this war is over. Normally the output is packed and sold by farmer-owned co-operative companies which also own the storage warehouses.

Another product of specialized agriculture in the Acadian-Appalachian Region is potatoes. Although potatoes are one of the most widely grown crops in Canada, two areas in this Region are so favoured geographically that they have achieved an international reputation for their product. In parts of Victoria and Carleton Counties in New Brunswick centring around the town of Perth, and in Prince Edward Island roughly 85,000 acres are ordinarily devoted to the growth of potatoes. Although the annual output is only about 13 per cent of the Canadian total, it is to be noted that it is grown on 8 per cent of the total Canadian acreage and that it provides most of the exports to foreign countries and a considerable part of the consumption of large cities like Montreal and Toronto. A product which is raised mainly for use by the grower or for sale on a limited scale elsewhere in Canada, becomes significant in the Maritimes because it is almost entirely on a commercial, and largely on an export basis.

Localization of commercial potato production in these two districts is the result of soil, climate, and a head start.[8] Potatoes will grow on all soils except the very poorest in nutritive value but they yield their highest amounts and their best quality on

[8]Boswell, V. R. and Jones, H. A., "Climate and Vegetable Crops", *U.S. Yearbook of Agriculture, 1941* (Washington), pp. 383-6; Ritchie, T. F., *The Potato in Canada* (Dom. Agric. Dept., 1940); Wilson, Ella M., "The Aroostock Valley", *Geographical Review*, vol. 16, April, 1926, pp. 196-203.



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deep friable loams of somewhat higher than average acidity. Friability is essential in order that the growing tuber develop quickly and acquire a good shape. Loams are ordinarily easily drained and, while retaining adequate moisture in normal years, do not become so wet in years with a higher than average rainfall that the potatoes rot in the ground. Loams have the further advantage that they contain sufficient nutriment to give high yields, whereas sandy soils, though easily drained, are likely to be deficient in humus and moisture. In both the areas mentioned the soils are almost ideal for potatoes. In Victoria-Carleton, which incidentally is just across the boundary from the important American potato country of Aroostock, Maine, the loams are the result of deposition by a retreating glacier. In Prince Edward Island the loams are derived from the weathering of the original sandstones under the action of water, frost, plants and chemicals.

Perhaps even more important than soils is the question of climate. Although potatoes are remarkably tolerant of weather and will grow under a wide variety of conditions they reach their best development when the temperature during the growing season is between 60 and 75 degrees Fahrenheit, and where the rainfall is regular. If both temperature and rainfall are too high, the plants develop vine at the expense of tubers, or "go to tops". If both are deficient, yield and quality are adversely affected. If the temperature is high and the rainfall irregular throughout the growing season, the potatoes are likely to be small and poorly shaped because they mature (go through the milk stage into the firm starchy stage) too quickly except in the neighbourhood of the eyes, where growth may begin again with better moisture. In this way knobs are formed on the potatoes. When rainfall is excessive potatoes rot in the ground regardless of temperature. A balance of climatic factors must always be considered. .Conditions in the two Maritime districts mentioned

are never ideal because nature, in temperate zones at least, provides wide variation in weather from one year to another. Nevertheless, these two districts approach more nearly to the optimum condition for potato growing than most other sections of Canada. As a result, New Brunswick and Island potatoes are of high quality, having good shapes with fine keeping characteristics and starch content.

It would be a mistake to attribute the specialization of potato growing in these areas solely to geographic factors. The mere fact that these districts began to produce potatoes on a commercial scale earlier than their neighbours has given them the advantage of a head start and the background of experience and the marketing organization which other districts cannot quickly duplicate even though their climate is not greatly inferior. As in most other cases of regional specialization, geographic factors co-operate with human ones to give agricultural leadership to a particular community.

Farmers in areas specializing in potatoes do not grow this product to the exclusion of all others. In Victoria-Carleton the influence of the surrounding area of hard rock is ever present.[9] Of the two million acres in these two counties only a little more than one-quarter was designated as farm land in 1931 and there were only a few more than 4,000 occupied farms. The average farm in these counties was 149 acres in size. On these farms 58 acres were in field crops, two-thirds of it being in hay and oats and 6 acres in potatoes. Most of the remaining land was in wood, with smaller amounts in natural or improved pasture. Even if one takes only those farms in these two countries which specialize very highly in potatoes, the average number of acres devoted to this crop on each farm is 40, and substantial amounts of land are still given over to hay and oats and to wood and

[9]McArthur, I. S., "Land Utilization in Carleton and Victoria Counties, New Brunswick", *Economic Annalist*, vol. 6, February, 1935, pp. 11-3.

pasture. In brief, although potatoes are the main crop and the economy of the community centres around this product, many other articles are produced, partly for sale abroad but mainly for consumption by the farmer himself or by his family or by his livestock. In Prince Edward Island, too, potato growing is part of a well-integrated farm management programme which places a good deal of emphasis on dairying. The reasons for diversification are the desire to escape the danger of price changes and the necessity for maintaining the fertility and friability of the soil.

Where potatoes are grown for sale in distant and often highly competitive markets, high quality is essential. When potatoes are produced on the same field for two or three years in succession and are grown in the same vicinity for several years on end, disease is likely to become prevalent. Thus farmers are under great pressure to eliminate disease in order to maintain quality. In Victoria-Carleton and Prince Edward Island they have to go to great pains to reduce if not eliminate the ravages of the potato beetle, of cutworms, of mosaic (leaf scab) and of dry rot. Such action is particularly important if the potatoes are grown for seed, as many of the potatoes in these areas are, because the very factors of climate and soil which lead to the production of potatoes in the first place encourage the production of virile, high-quality seed. In order to assist the potato farmer in combating disease the government has established experimental stations to conduct research. Also it has set up grades for potatoes so that the purchaser is assured of uniform quality. It also certifies seed. By inspecting seed plots before and after harvest, it tries to insure that seed for sale either at home or abroad is free from serious disease and has purity of variety.

Potatoes make rather heavy demands on the soil and, conversely, quickly respond to fertilizers by yielding larger crops and better grades. In order to secure animal manures, farmers

raise livestock. Alternatively they apply large amounts of artificial fertilizers. More commonly they follow a crop rotation of grain seeded with clover in one year, hay the following two years, then potatoes followed by grain, and so on. In this way potato growers provide themselves with several sources of income and, by ploughing under the hay in the third year, they return to the soil substantial amounts of humus and nitrogen which go far toward supplying the necessary nutriments for the important potato crop.

Aside from production, the main problem facing the potato growers is that of markets. Potatoes are grown in almost all parts of North America and the Maritime product has to be sold in competition with tubers produced on farms in close proximity to the markets. On account of their bulkiness and perishability, transportation charges on potatoes are an important factor in determining where Maritime potatoes can be sold, especially when prices are low. Due to variations in the weather from one year to another, the annual crop varies greatly in amount both in the Maritimes and in the localities near the different markets. As a result, prices in the Maritimes fluctuate greatly. Returns per acre of $188 in 1925 fell to less than $27 in 1931. The farmer who relies on potatoes for his only revenue has a very erratic income and even for those—the greater number—for whom potatoes are the main but not the only revenue, farm income is uncertain.

Some Maritime potatoes are sold in Montreal and Toronto where on account of their superior quality they command a premium over the locally grown product, but the main market is abroad. Increasing difficulty has been experienced in reaching foreign markets because of adverse tariff action by the United States and, later, by Cuba and other West Indian islands. In spite of the tariff wall, the exceptional virility of Maritime potatoes enables limited quantities to be sold in these areas for

seed but the virtual loss of many of the foreign markets for the general run of potatoes is serious. An effort has been made to create a local market, especially for "culls", by storing potatoes in silos and using them as feed for hogs as is done in Germany. Unfortunately, farmers in the Maritimes are not accustomed to raising hogs on a large scale and hesitate to undertake this new type of business. An alternative use for culls and surplus production is the manufacture of starch and industrial alcohol. If used for these purposes potatoes would have to face competition of alcohol from molasses or wood, and of starch from corn. The latter is very much cheaper than potato starch and is better for most purposes except for making high-grade dextrine which is used for treating printed fabrics of superior quality. Alcohol from other sources is also cheaper than alcohol from potatoes.

In Prince Edward Island fox farming is another type of specialized "agriculture" which has developed.[10] This industry is favoured by climate. The cold winters and the relatively cool short summers have forced the animals to grow heavy pelts. The gently rolling surface of the island makes drainage easy. This is an important matter because in captivity the foxes contaminate the ground, serious diseases develop and unless the drainage is good the foxes soon sicken and die. The soil is important also in localizing fox farming. Foxes are burrowing animals and the wire fences of their pens must be imbedded in the soil. By burying the fence down four or five feet through the friable, easily drained top-soil to the comparatively hard stony sub-surface or hard-pan and then turning it in a foot or two, fox farmers prevent the animals from digging their way out of their pens. The fences must be high enough so that the

[10]Prince Edward Island, Department of Agriculture, *Report*, annual; Stilgenbauer, F. A., "Geographic Aspects of the Prince Edward Island Fur Industry", *Economic Geography*, vol. 3, January, 1927, pp. 110-25.

foxes cannot jump over the top. They are erected to heights of nine or ten feet above the ground depending on the depth of snow in winter and are built with an overhang of a foot or two at the top to stop foxes crawling up over the fence and escaping.

Fox farming in Prince Edward Island is also facilitated by the fact that the surrounding sea provides a supply of fresh fish for feed. The foxes are also fed fresh meat, milk, cereals, and specially prepared biscuits. They will not eat stale or putrid meat and their food has sometimes to be kept in cold storage. The problem of providing a diet which is cheap and at the same time one which will ensure normal growth and good health on the part of foxes has been a difficult one and is not yet completely solved. To deal with the diseases which animals in the process of being domesticated acquire, a special and rather elaborate veterinary science has been evolved.

After the people of the Island had solved the initial difficulties of domesticating a wild animal, other areas began to raise foxes too. Fox farmers on the Island made large profits from selling foxes for breeding purposes, as much as $30,000 being paid for one pair. After the demand for breeding stock had been more or less satisfied, the producers settled down to supplying the demand for furs. Prices fluctuate with changes in fashion and the industry is unstable on this account. The problems of domestication are not yet solved even though substantial progress has been made. It is important to note how, by using a rather obscure natural resource and taking advantage of local geographic conditions, the Prince Edward Islanders have not merely brought a considerable measure of prosperity to themselves but have also established a type of farming which is likely to become of steadily increasing importance throughout the world. Fur farming is now being carried on in all the provinces of Canada and animals other than foxes are being raised in captivity.

Besides the farming areas specializing in apples, potatoes and fox furs, there are a few districts of reasonably prosperous general agriculture. These districts are not composed of wide or continuous plains of cultivated soil nor of broad river valleys. Instead, the general farming areas consist of numerous small sections where limestone or sandstone have weathered down into soils of fair fertility or where the smaller rivers have deposited detritus. These patches are separated from each other by rocks, swamps, or less fertile soil but the proportion of good land to total area is higher than throughout the Acadian-Appalachian Region as a whole. The result is that mixed farming can be carried on with a moderate success. Agricultural production is limited to short season crops of the temperate zone. The growing season is generally too short and cool for corn, and too cool and damp for wheat though small amounts of both are grown. Oats and barley are raised successfully but the emphasis is on hay and pasture. The soils, like all podsols, need careful attention if yields are to be maintained.[11]

Mixed farming areas are located along the north shore of Nova Scotia, in Prince Edward Island and in the valleys of the Musquodoboit, Petitcodiac, Kennebecasis, Miramichi and other rivers. In the vicinity of Yarmouth, Shelburne and Bridgewater the generally barren, crystalline rocks have a few good farming communities on the drumlins. The valley of the St. John River between Saint John and Fredericton is fertile. Here the river wanders back and forth across an alluvial plain with practically no gradient because its progress is impeded by the ridge of hard rock which forms the basis of the Reversing Falls. As the velocity of the river declines, its capacity to carry detritus in suspension is reduced and the considerable amount of silt which the river has eroded in its narrow, deep upper valley is

[11]Putnam, D. F., "Farm Distribution in Nova Scotia", *op. cit.*

thus deposited on the plain. In the Eastern Townships the low hills and intervale soils yield livelihood to thrifty farmers.[12]

The Tantramar marshes near Sackville and the meadows at Grand Pré in the "Land of Evangeline", produce large quantities of high-grade hay. These lands, long ago dyked to protect them from the tides of the Bay of Fundy, have been used for more than three centuries with practically no application of animal or chemical fertilizers. Instead, the dykes are occasionally broken and the tide allowed to flow in. During the course of two or three years the land is covered with a thick layer of new mud. The dykes are then rebuilt and the drainage ditches opened. In this way the land at almost no expense is restored to its original fertility. These marsh or meadow lands were created by the extraordinarily high tides in the Bay of Fundy which have scoured the soil from places where it has been carried down by inflowing streams and then thrown it up on the land toward the head of the Bay.

The total area of land in all these districts of specialized agriculture and prosperous mixed farming is not large relative to the total size of the country. Only in Prince Edward Island and the Eastern Townships is a large proportion of the land cultivated. In Nova Scotia only 6.4 per cent of the land area has been improved by drainage and dyking. At least 80 per cent of New Brunswick and the Gaspé Peninsula is so devoid of fertile soil that agriculture can be carried on only in patches surrounded by a wilderness of granite. In most places barren rock appears at the surface. Sometimes the rock is loosely covered with glacial drift and the resulting soil is stony and infertile. Marshes and bogs with cold, water-logged soil are common. In some spots the top-soil appears to be good but the subsoil is heavy and not suitable for the downward movement of water.

[12]Bélanger, C.-E., "Les Cantons de l'Est", *Études Économiques*, vol. 2, 1932, pp. 411-51; Dresser, *op. cit.*

Since the internal drainage is poor, the soils remain cold and wet in the spring thus delaying seeding, shortening the growing season and lowering the yield. The fundamental cause of this condition is geological for the effect of glaciation was to leave little soil on the uplands and the rivers have not had time to build up extensive alluvial plains.

Cape Breton county can be taken as typical of the conditions which generally exist outside the apple, potato, dairying, and fur-farming districts. Less than 6 per cent of the area of the county is improved farm land and the general appearance of the farms which do exist is poor. "The poor development in Cape Breton is due to several physical factors. The county is rough and in some cases almost mountainous with many out-croppings of rock. Considerable areas . . . are unproductive. Soils of low natural fertility are most common and adequate drainage is lacking in many portions of the county. The spring season is late and this prevents local farmers from securing the benefits of the early market. There are many idle acres on the farms and a number of idle farms. That these areas, once cultivated, should now be idle may be an indication of the difficulties and disadvantages of farming, even within a 35-mile radius of industrial centres, [Sydney] in which there are nearly 90,000 consumers."[18]

In most of the areas with geographical conditions similar to those just described, farming is of a self-sufficient or pioneer type. The farmer produces enough food to support himself and his family at a low standard of living, but very little is raised for sale. In the neighbourhood of mining and lumbering centres there may be a little dairying or truck farming. On many farms

[18]Horton, L. G., and Reid, E. P., "Cape Breton Farmers and the Sydney Market Area", *Economic Annalist*, vol. 9, August, 1939, p. 61; Longley, W. V., and Chown, W. F., *Antigonish County* (Halifax: N.S. Agric. Dept., 1936); Gosselin, A., and Boucher, G. P., *Settlement Problems in Northern New Brunswick* (Dom. Agric. Dept., 1944).

outside income from work in fishing, mining, and lumbering is an important part of the total earnings of the farmer. The outside work is forced on the farmer by poor soils, climate, and access to markets. Usually the outside occupations lead the farmer to neglect his land which progressively deteriorates in productivity. In Gaspé and in northern New Brunswick French-Canadians manage to secure a modest living, but in most parts of the Region outside of a few favoured areas of specialized agriculture, the cold hard facts of poor soil and drainage have led to abandonment of farms and general deterioration of the countryside. Many of these areas should never have been cultivated at all but have been left in forests to which, sooner or later, they will probably revert.[14]

The governments of Nova Scotia and New Brunswick are deeply concerned about the generally unsatisfactory condition of agriculture in these two provinces.[15] In spite of the long period of settlement and the existence of some measure of prosperity in the past, agricultural population is declining, abandoned and run-down farms are common, and the provinces do not provide for their own requirements in grain, eggs, poultry, beef and dairy products. The governments are encouraging better farming practices and are aiding in the construction of creameries. It seemed obvious that dairying and livestock offered definite possibilities in a Region which has much rough land, small scattered areas of fertile soil, and a climate suited for the growth of hay. But in order to operate at low cost a creamery must have a certain volume of raw material. Some of the farming patches are too small to allow even the smallest-sized commercial creamery to function at low cost. Of course cream can be gath-

[14]Taylor, E. M., "Land Settlement in New Brunswick", *Scientific Agriculture*, vol. 23, December, 1942, pp. 217-9; "Land Utilization in New Brunswick", *Economic Annalist*, vol. 24, March, 1940, pp. 27-31.

[15]Nova Scotia, Department of Agriculture, *Report* (Halifax), annual; New Brunswick, *ibid.* (Fredericton) annual.

ered from a large area, but any economies in manufacture because of larger volume are more than offset by the expense of hauling cream over poor roads, past abandoned farms and rocky outcrops. The raising of sheep, hogs, poultry, and beef cattle all have possibilities but all run into difficulties, arising out of the geological structure of the country and the fact that most agricultural products can be raised in other areas with geographic advantages and shipped into the Maritimes for sale at lower prices than they can be produced at home. Undoubtedly the Maritime farmers might increase their production of certain farm products if they improved their farming methods. In particular they should take better care of their pasture and feed their cattle more efficiently.[16] Nevertheless, the natural disabilities are so great that human ingenuity finds it hard to overcome them.

In brief, in the cases of apples, potatoes, and fox furs, the farming of the Acadian-Appalachian Region is highly specialized in districts with considerable economic and geographic advantages. In Prince Edward Island, the Eastern Townships, and some other places dairying is flourishing. Elsewhere, on the poorer soils and in the more isolated communities, agriculture is subsidiary to fishing or lumbering in the sense that it is something to be carried on when work is not available in the main occupation or is to be done by the wife and children when the man of the place is on the sea or in the woods. In these latter instances methods are crude and the output is small in amount, of poor quality and used mainly at home.

[16]Garvin, W. J., *Some Factors Affecting the Supply of Milk and Milk Products in Nova Scotia* (Washington: Catholic University of America, 1941); Maritime Feed Committee, *Feeds and Feeding for Livestock in the Maritime Provinces,* (Dom. Agric. Dept., 1940); Walsh, F. W., and Keirstead, W. C., "An Agricultural Policy for the Maritimes", *Proceedings Canadian Society of Agricultural Economists,* 1936, pp. 60-72.

Mining

In 1939 the hard rocks of the interior of Nova Scotia produced about one per cent of the total Canadian output of the precious metal. The gold-bearing rocks are scattered over an area 275 miles long and from 10 to 75 miles wide down the backbone and the southeastern slopes of Nova Scotia.[17] The ores are definitely low grade. The amount of gold per ton of rock is small, it is present in only thin veins, the more accessible metal was exploited long ago, and what remains is expensive to extract. Rocks and sands near the headwaters of the Chaudière River in the Appalachian district yielded considerable values of placer gold in the 1860's but production has long since become negligible.

In the Appalachian sub-region asbestos[18] is the most important mineral, with production centring at Thetford Mines and Danville. Asbestos is a non-metallic mineral occurring in veins in hard rock. After extraction the mineral is easily "fluffed-out", its fibrous character giving it a woolly appearance. The mineral is soapy to the feel, tasteless, odourless, impervious to decay, water and dyes, a non-conductor of electricity and non-inflammable. The highest grades can be spun into cloth which is used for fireproof clothing and theatre curtains. Poorer-quality asbestos is used for brake linings, for insulation, and for making shingles, smoke ducts, and oven parts as well as millboard for insulating electric switchboards.

Canada produces about 80 per cent of the world's supply but her two competitors, Russia and Rhodesia, provide longer fibres. Most of the Canadian output is made up of short and medium

[17]Nova Scotia Dept. of Mines, *Report* (Halifax), annual; Moore, E. S., *The Mineral Industry of Canada* (Toronto: Ryerson Press, 1928), pp. 91-116; Harrington, G. S., "The Mining Industry in Nova Scotia", *Bulletin Imperial Institute*, London, 1928, pp. 68-9.

[18]Elliott, T. R., "Fibres of Gold", *Canadian Geographical Journal*, vol. 16, March, 1938, pp. 109-26; Department of Interior, *Natural Resources of Quebec* (Ottawa: 1929), pp. 79-81.

fibres which are worth, per pound, only about 5 per cent of the superior grades. A steady market must be found for the poorer quality if the better grades are to be mined profitably. Hence, Canadian producers have aggressively sought outlets in industry and the insulation of houses against heat and cold.

Most of the mineral is obtained from open pits. The overburden is removed and the ore body exposed so that huge steam shovels can dig up the ore and drop it in open railway cars for transportation to the mill. Eventually the pit takes on the appearance of a vast amphitheatre, with steam shovels and trains operating on various benches. The dust which is given off during the milling operations covers wide sections of the country round about the mines.

Elsewhere in this Region the hard rocks contain other minerals—zinc and lead in central Gaspé and zinc, lead and copper near Stirling in Cape Breton Island. None of these is present in quantities large enough to justify extraction on a commercial scale under normal conditions. When prices were high during the first World War manganese, antimony, arsenic and lead were obtained in Nova Scotia.

The stratified rocks of the Acadian-Appalachian Region contain much more mineral wealth than the igneous ones. Gypsum outcrops in cliffs varying in height from 50 to 200 feet at numerous points in the northern half of Nova Scotia. Although these outcrops occur as far east as Antigonish, the most important ones from a commercial point of view are those near Windsor on Minas Basin, where cheap water transportation to markets in the United States is available. Gypsum is also mined near Hillsboro, 25 miles south of Moncton, New Brunswick. Ample reserves are available elsewhere as well. The product is used for plaster of paris and for wallboard in construction.

Salt is produced at Malagash, 42 miles west of Pictou, Nova Scotia, where a reserve estimated at 25 million tons is available at

a depth of only 85 feet below the surface. The deposit is exploited by underground mining with shafts and tunnels. This is in contrast to most of the other salt-producing districts in North America, where water is allowed to run down pipes to the salt beds in order to dissolve the salt. The brine is then pumped up and evaporated. The annual production at Malagash is about 50,000 tons which is used locally for general household and agricultural purposes, in the fishing industry, and for preserving mine timbers. The development of salt mining here was long delayed because of the ease of bringing in supplies from outside by water.

By far the most important mineral in this Region is coal.[19] The most valuable field is in the vicinity of Sydney, for a distance of 35 miles between Mira Bay and Cape Dauphin in Cape Breton Island. This area supplies about 75 per cent of the total output of Nova Scotia and produces the best quality. Smaller fields are worked at Inverness, New Glasgow, and Stellarton and in the Cumberland field on Chignecto Bay not far from Springhill. Minor amounts are available near Minto on the north shore of Grand Lake in New Brunswick. Some of the latter output has been used since 1906 to produce electric energy at a plant located at pit-mouth. In effect, low-grade coal is sent to market in the shape of electricity.[20]

[19]Forsey, Eugene, *Economic and Social Aspects of the Nova Scotia Coal Industry* (Toronto: The Macmillan Company of Canada Limited), n.d.; Gray, F. W., and R. H., "Sydney Coalfields", *Transactions of the Canadian Institute of Mining and Metallurgy* (hereafter referred to as *Trans. C.I. M.M.*), 1941, pp. 289-330; Gray, F. W., "The Future of the Sydney Coal Field", *Dalhousie Review*, vol. 21, July, 1941, pp. 178-83; Harrington, *op. cit.*, pp. 65-7; Mifflen, S. C., "The Submarine Coalfield of Sydney", *Transactions C.I.M.M.*, 1941, pp. 331-54; Moore, *op. cit.*, pp. 158-71; Patton, M. J., "Coal Resources of Canada", *Economic Geography*, vol. 1, March, 1925, pp. 73-88; Royal Commission on the Acadia Coal Company, *Report* (Halifax: 1939).

[20]Avard, N. T., "Pulverized Coal as a National Asset", *Trans. C.I.M.M.*, 1937, pp. 376-83; Stephens, J., "An Economical Use for New Brunswick Coal", *Engineering Journal*, vol. 20, July, 1937, pp. 533-8.

The total reserves of coal in all these areas are sufficient to last for nearly 200 years at the present rate of production and with current costs and prices. All of the coal is good for steam-raising purposes and that in the Sydney area is excellent for coking. The reserves are close to ocean transportation and, with the exception of a little poor quality coal in the Hudson Bay Lowland, Manitoba and Saskatchewan, there are no other coal reserves in Canada east of Alberta nor none so close to tide-water at any point along the Atlantic coast of North America.

In spite of these advantages coal mining has had an uncertain prosperity in recent years. In part this is due to the fact that coal is used largely for industrial purposes and its consumption fluctuates to a marked degree with the business cycle. More important are the geographical limitations under which coal mining here is carried on and which more than offset the natural advantages. About half the coal comes from submarine sources. The outcroppings of coal in the Sydney area dip gently beneath the sea, stretching outward without faulting or appreciable change in quality. The coal strata extend for an unknown number of miles under the sea but when the depth of the overlying rock approaches 4,000 feet—at a distance of six or seven miles from shore—the weight of the rock cover will be so great that coal cannot be extracted without expending so much effort in labour and materials to support the roof that mining will be uneconomical. At present some coal is being mined at between three and four miles from shore. The seams are comparatively thick—3 to 7 feet—and there is plenty of rock cover to allow a large proportion of the coal to be extracted. Nevertheless, a good deal of coal—upwards of 40 per cent—has to be left behind in the form of pillars or walls to support the roof or, alternatively, pit props of lumber have to be used. When coal is mined under ordinary conditions the pillars or walls can often

be removed and the overlay of rock allowed gradually to subside. This is obviously impossible in submarine mining if the coal beyond the present workings is to be extracted.

As the working face of the mine is pushed farther seaward and deeper into the earth (on account of the dip of the seams), it becomes more difficult and expensive to provide adequate ventilation, power and light for operations, and tramways and power to pull the mined coal inward and upward to the base of the shaft. In ordinary operations a new shaft would be sunk just beyond the present working face but this is impossible in submarine mine. Moreover, under the agreements which have been entered into between the management and the workmen, miners are paid from the time they enter the top of the shaft until they emerge after their day's work is done. Since it takes a good deal of time for the men to travel from the shaft to the face of the coal on which they work and since considerable numbers of men are necessarily engaged in ventilation and transportation within the mine, the number of workers actually extracting coal relative to the total number of men employed in the mine is higher than in other fields in America.

The mines located solely under the dry land as in the Pictou and Cumberland areas are able to escape some of these disabilities but the quality of their coal is inferior to that of the Sydney field. Their reserves are being rapidly used up and mining is difficult. Particularly in the Pictou district the coal measures are excessively faulted, individual coal beds are uneven in depth below the surface, the quality of the coal varies suddenly within short distances, and large amounts of dangerous gases often accumulate due to the irregular ventilation passages.

Coal producers in this Region normally experience difficulty in marketing their product. In common with coal areas elsewhere they face competition from petroleum, used either as fuel oil for steam-raising purposes or in Diesel engines, and gasoline. What

is more, steam engines have been improved, combustion is more complete and the same amount of coal will generate a larger amount of energy than heretofore. In 1938 one ton of coal would produce as much electricity in the best type of plant as did 4.44 tons of coal in 1902. Not all steam-electric plants in operation to-day are as good as the best, and the savings of coal in railway transportation, smelting, coke manufacture and so on have not been as spectacular as the economies in stationary boiler operation. Savings in coal were due less to a few epoch-making inventions than to the cumulative effect of many small economies. As these new methods become more generally adopted average performance will be brought up to the level of the best present performance and coal consumption may be expected to decline further.[21] Consumers gain from these technological advances but the coal-mining industry suffers, at least in the short run, because the market for coal has shrunk.

Aside from these factors which apply to coal mining in general, Maritime producers have special problems of their own. The natural market for their product is in the coal-less but industrialized New England States. Unfortunately, this outlet is cut off by the United States tariff and by the ease of bringing coal to that area from Virginia and West Virginia. The main Canadian market is in the populous and highly industrialized St. Lawrence Lowlands but this Region is about twice as far from Sydney as it is from the Pennsylvania mines and prefers to buy coal from the nearer source. Furthermore, Pennsylvania coal is of a higher thermal content, has relatively little ash, is cleaner and requires less care in domestic firing than the Maritime article.

Although the Maritime producers have access to cheap transportation along the St. Lawrence River, this is offset by the fact

[21]National Resources Committee, *Energy Resources and National Policy* (Washington: 1939), p. 375.

that the route is open only in summer, while domestic and to some extent industrial consumers prefer to buy in the early fall and winter. A further disability is that the lower-grade Maritime coals tend to disintegrate or degrade in transit or in storage more rapidly than the harder coals from Pennsylvania. Therefore it is often not economical to send coal up the St. Lawrence River during the summer and store it for some time in anticipation of winter needs. Moreover, the St. Lawrence is available to coal producers in Scotland, Wales, Belgium and even Russia and Indo-China who are able to sell their product in the Lowlands in competition with both Maritime and American coal.

In order to offset the geographic disabilities of Maritime producers the Dominion government has applied a tariff against foreign and British coals, and gives concessions on the freight rates and direct subsidies when Canadian coal is used for coking and gas making. As a result of this aid nearly one-third of the output of Maritime coal is sold in the province of Quebec and the eastern end of Ontario. West of Montreal and Ottawa, Maritime coal is not sold regularly due to the lower transportation charges on American coal coupled with the inertia of the consumer in changing his firing methods to a new type of product and the better quality of the American article.

Of the output of coal which is not sent to Quebec, some is used in the factories and homes of the Maritimes and by railways, small quantities are sold for bunkering ships, but the greater part is used in the iron and steel industry of Sydney. Nova Scotia's resources of iron ore are negligible but on Bell Island in Conception Bay, Newfoundland, is a large reserve of high-grade ore. This is brought by ship and in conjunction with local supplies of limestone and coal is used to produce iron and steel in Sydney.

The ferrous industry here has the advantage of having raw materials which are near at hand from a transportation stand-

point, but the price of coal is high for the reasons given. The Sydney mills were originally built to supply the large Canadian demand for steel rails for the rapidly growing railway network. This market is now declining and the chief market for primary iron and steel is sheet metal for use in automobiles, rolled plate for containers (tin cans and barrels), beams for construction, and for wire and pipe. The market has changed and the original productive facilities at Sydney are becoming out of date. Besides, modern methods of producing steel require fairly large amounts of scrap metal which is available mainly in densely populated districts. Thus, as a result of changes in demand and production methods the Sydney steel industry has moved relatively farther away from its raw materials and has a plant less well fitted to supply the needs of the market than before.

Nevertheless, the Sydney area is far from disappearing as a steel producer. It still has some advantages of location with respect to raw materials; it has the benefit of being under the control of one company which is able to co-ordinate and introduce new methods into mining, transportation and mill operation; and it has tariff protection on most of its finished products. Even so, it is functioning under disabilities. Especially in times of general business depression, these show up in unemployment, labour difficulties, and low return on invested capital. The surprising thing is that the Nova Scotia steel industry has been able to resist the unfavourable facts of geography and economics for so long and so successfully.

The metamorphic rocks of the Region supply stone for building purposes. Sandstones and granites quarried at several points in this area have been used in public buildings in Halifax, Saint John, Fredericton and Ottawa. Limestone from Louisbourg is used as flux in steel making. Before emery wheels, carborundum and other abrasives were manufactured synthetically, New Brunswick produced pulpstones and grindstones.

In the vicinity of Moncton about 80 wells produce natural gas of high heating value, along with small amounts of petroleum. Most of the latter is diffused through shale and cannot be obtained by drilled wells. The cost of mining the shale and of extracting the petroleum from it by heat or other processes is too expensive in comparison with the price of petroleum obtained in other parts of the world by pumping from natural underground reservoirs. The shales are of potential not of immediate value.[22]

Forestry

Forests[23] constitute an important source of wealth in this economic Region. Despite the long period of settlement, about 68 per cent of the total land area of Nova Scotia and 78 per cent of New Brunswick is still forested. Woodland constitutes a large percentage of the farms even in such relatively advanced agricultural areas as the Annapolis Valley and Victoria-Carleton counties. In Nova Scotia the receipts from these farm woodlots were valued, in 1931, at about 12 per cent of the total farm income of the province. The woodlot supplies much of the farmer's own requirements for fuel, fence posts and building materials and if properly managed is a continuing source of wealth. Sometimes almost all the standing timber on a farm is logged off to meet some large expense such as paying off the mortgage, or to provide an income which is not wisely invested. Frequently the cattle are allowed to pasture in the woods. They destroy the young seedlings, with the result that when the mature trees are cut down or the "over-ripe" trees die, the forest does not regenerate itself. In either case the farm has lost a resource of value. Unless efforts at reforestation are made, the farm is left poorer than before and the current income from the

[22]Nova Scotia Economic Council, *Report* (Halifax: 1936).

[23]Morison, M. N., *The Forests of New Brunswick*, (Ottawa: Forestry Branch, 1938).

farm woodlot constitutes a long-run loss. A woodlot ought to be managed properly like any other agricultural or forest resource.[24]

More significant than the woodlots on almost every farm are the forests, sometimes in their virgin state, which cover extensive areas. In the southwestern part of Nova Scotia, in the St. John Valley and on well-drained ridges elsewhere there are many hardwoods—yellow birch, maple and other species. Sometimes these occur in solid stands but more usually they are mixed with softwoods. The hardwood is used for fuel, flooring, furniture, cooperage, veneer stock, implement handles and construction. Relatively small mills are located at strategic points throughout the Region to manufacture the hardwood. The industry is handicapped by the ease with which lumber can be brought in for building purposes through the Panama Canal to Eastern Canada and the United States and sold at lower prices than it can be produced locally. It is difficult for the Maritime lumbermen to sell their product in the St. Lawrence Lowlands because the cost of transportation is high and it is difficult to sell in New England on account of the tariff. In the main the hardwoods are used locally.

At least 60 per cent of the stand of timber in the Acadian-Appalachian Region is softwood. This term does not mean that softwoods are necessarily "softer" than the so-called hardwoods. For example, basswood, a hardwood, is very easily worked, whereas white spruce is tough. The distinction lies in the fact that all softwoods have needle-like leaves and produce their seed in cones. Hardwoods or deciduous trees have broad leaves which drop in the autumn. The softwoods or conifers (except larches) are evergreen. They lose their leaves gradually throughout the year and not entirely at one season. The most common softwoods of the Acadian-Appalachian Region are spruce, white

[24]Morton, B. R., *Care of the Farm Woodlot* (Ottawa: Forestry Branch, 1920).

pine, jack or banksian pine, balsam fir, cedar, and larch or tamarack. These woods are used for the cheaper types of construction, for boxes and shooks, and for pit props. A more important use is for manufacturing newsprint in mills located at Dalhousie, Athol, Bathurst and Edmundston (pulpwood only) in New Brunswick and at Liverpool, Nova Scotia. Altogether these mills have about 8 per cent of the total Canadian capacity. The geographic factors affecting their location and the economic problems which they face are substantially the same as those in the mills of the Canadian Shield and will be discussed in connection with that Region.

Exploitation of these pulpwood resources is greatly assisted by the climate and topography of the Region.[25] The trees are felled beginning in the early autumn. As soon as there is a light fall of snow the logs, trimmed of their tops and branches, are hauled or "twitched" by team to a "yard" or assembly point which may eventually contain as many as 500 logs. When enough snow has fallen to make good roads, the logs are hauled on sleds from the yard to the banks of fair-sized streams. Sometimes the roads are improved by sprinkling them with water to give, after freezing, a hard smooth surface. Felling continues until the thaws occur about the middle of March. After that date it is difficult to get the logs out during that season. Also felling must cease when the spring thaw comes because the quality of logs is greatly reduced by rot and borers if they are allowed to remain in the woods until the next winter.

As soon as the ice begins to move out of the river the logs on the banks are rolled in, and "driven" down stream to the mill which is located at its mouth. In order to facilitate the drive, the river may have been straightened or deepened or cleared of leaning trees and other debris which would obstruct the pro-

[25]Riordon, C. H., "Lumbering in Quebec", *United Empire*, vol. 29, March, 1938, pp. 111-5.

gress of the drive. Occasionally light dams are built to provide deep water so that the logs will float over flat areas or will be carried along by the rush of water when the dam is suddenly broken. Every effort is made to insure that all the logs dumped into the upper reaches of the river actually reach the mouth, for every log which is "hung up" is a financial loss. On the larger rivers, where the logs of several companies may be driven at about the same time, the logs are marked or branded. A separate company, or sometimes a co-operative formed by the lumbering companies, handles the drive of all the logs and then sorts them out at destination. Logs may be driven for distances of from a few miles to upwards of one hundred.

The processes of logging and transportation are designed to take advantage of the climatic and geographic conditions. The heavy snows, the lateness of the spring, the glaciated terrain with its many lakes and streams, the light weight of the softwoods and the fact that immersion in water even for considerable periods does not adversely affect their quality are all factors leading to the continuance of practices which in the eyes of Hollywood are merely picturesque. The use of tractors for hauling logs is increasing but machinery is not likely to displace the traditional methods because of their cheapness. As is the case elsewhere in Canada the conservation of forest resources is becoming increasingly important.

Hydro-Electric Power

The glaciation of this Region created a number of sites suitable for the generation of hydro-electrical energy. The economic factors involved in the development of this power will be discussed in connection with the Shield where similar geographic conditions prevail. The amount of energy which it is theoretically possible to develop at ordinary six months' flow in New Brunswick and Nova Scotia is about 300,000 horse-power or 8 per

cent of the total Canadian potential. Due to the relatively smaller size of the rivers, the sites have smaller capacities than those of the Shield but are more scattered and many of them are more accessible. Some of the water-power is already being used to generate electricity and also drive saw-mills and grist-mills directly.

A very large possible source of power is the tides.[26] As the tides come in they could be directed by piers or dams through relatively narrow channels where they would drive electrical generators. When the tides had reached their peak the dams would be closed and during periods of low tides the water would be allowed to escape through turbines from the enclosed basins, thus generating more electricity. The basins would be constructed in two "stages", that is, with two sets of dams, so that power could be generated with the flow of water from one basin to the other as well as from one basin to the sea. So far, the project of tidal power is still in the experimental stage though the Americans began a scheme at Passamaquoddy Bay near the International Boundary. The exceptionally high tides along the Bay of Fundy and the narrow estuaries along its shores make this area unusually suited to this type of development once its practicability has been proven. It has been estimated that the harnessing of the tidal power of Minas Basin would generate 100,000 kilowatt hours daily. At Digby Gut at each tide twenty-one billion cubic feet of water runs in and out with a velocity of five miles per hour at half-tide and an average rise of 27½ feet. The channel is about one hundred yards wide at its narrowest point.

[26]Turnbull, W. R., "Proposed Hydro-electric Power Development of the Petitcodiac and Memramcook Rivers", *Report of Smithsonian Institution* (Washington: 1923), pp. 523-46; Special Committee of the Senate on Railways, Canals and Harbours, *Report* (Ottawa: 1944).

Fishing

The fishing industry of the Atlantic coast adjacent to the Acadian-Appalachian Region is greatly affected by the geography though the details of the inter-relationships have not, as yet, been completely worked out. The waters off these shores constitute one of the world's richest "pastures" for commercial fish. The most common plant in these pastures and the basis of the animal life is a single-celled alga called a diatom.[27] The minute size and enormous numbers of these plants can only be imagined, for a quart of water may contain as many as six million of them. Sometimes in the Arctic they are so abundant that they colour the water for miles and give it a noticeably "smooth" feeling. The body of the diatom is enclosed between two lids or valves which fit together like the bottom and cover of an old-fashioned pill-box. The cover is made of silica, often highly decorated, and may be shaped like an oval, a crescent, an "S", or a canoe. Within the body is a fluid which is closely related to chlorophyll, the colouring matter of the leaves of land plants. This fluid uses the gases, chiefly carbon dioxide, and the salts, especially nitrates and phosphates, of the sea water in the presence of sunlight to give life to the alga. The oily character of this fluid makes it very nutritious to fish. Diatoms have no organs of locomotion but are carried by currents. They may swarm in certain areas at certain times and then may forsake the area almost entirely because of lack of food. Diatoms reproduce by division and at an amazing speed under favourable conditions. In addition to diatoms, there are many other types of algae. Collectively all these unicellular plants are known as plankton.

[27]Clark, A. H., "Life in the Ocean", *Rpt. of Smithsonian Institution* (Washington: 1923), pp. 369-94; Labour, W. V., "Floating Plants", in Fowler, G. H. and Allen, E. J., *ed., Science of the Sea* (Oxford: The Clarendon Press, 1928), pp. 150-64; Sverdrup, H. V., Johnson, M. W., and Fleming, R. H., *The Oceans: Their Physics, Chemistry and General Biology* (New York: Prentice-Hall, Inc., 1942).

The plankton are consumed directly by animals such as radiolarians with structures very similar to those of diatoms, and small crustacea which breathe through gills and have outer shells of carbonate of lime. These members of the animal kingdom, small though they are, assemble the microscopic plants into units of appreciable size and upon them, in turn, feed herring, capelin, and the young of all other marine fish. The smaller-mature fish and the fry of all species supply the food for creatures which are larger and biologically more complex. Eventually the plankton, now converted into commercial fish, are consumed by man.

The wealth of plankton off Canada's Atlantic coast is due to a number of topographic and "climatic" factors.[28] Stretching along the edge of the continent and trending, like the coastline in a southwest to northeast direction, is a shelf formed of a series of submerged table-lands called banks. The largest of these is the Grand Bank of Newfoundland with an area of 40,000 square miles, or twice the size of Nova Scotia. Southwestward are the St. Pierre, Banquereau, Sable, Le Havre and George's banks. These banks are submerged to various depths but rarely more than 50 fathoms (300 feet), except that along their seaward edges they slope gradually to depths of about 100 fathoms and then drop sharply to more than 1,000 fathoms. The banks are separated from the shore by a basin and from each other by channels about 100 fathoms deep. If the banks were exposed above the surface of the sea we would describe them as gently sloping plateaus incised by great canyons.

Flowing up along the east coast of North America from the tropical regions is a broad current of moderately warm water (59° F.) of high salinity known as the Gulf Stream. The

[28]Huntsman, A. G., "Oceanography", *Handbook of Canada* (Toronto: University of Toronto Press, 1924), pp. 274-90; Jones, C. F., and Darkenwald, D. G., *Economic Geography* (New York: The Macmillan Company, 1941), pp. 45-56; Matthews, J. H., "Fisheries of the North Atlantic", *Economic Geography*, vol. 3, 1927, pp. 1-23.

rotation of the earth, the configuration of the shore-line and, later, the influence of the prevailing westerlies cause this current to be deflected toward Europe off the coast of Nova Scotia and Newfoundland. In the meantime the arctic water of the Labrador Current flows southward, changing its character slightly by the addition of off-shore oceanic water as it goes. The main body of this current meets the Gulf Stream in the vicinity of the Grand Banks where the two currents mix along a vertical line of demarkation, a sort of wall or front. The "front" shifts somewhat with the season, moving off shore in winter and on shore in summer.

The coastal waters in the basin between the continental shelf and the shore-line of North America are in circulation at the rate of about 2 to 6 miles per day, normally in the shape of an eddy generated mainly by the action of the tides though partly by the rotation of the earth, the difference in density due to local heating and the admixture of fresh water. In each eddy water from the north is mixed with fresh water from the rivers and sometimes with colder water upwelling from the depths. This complex mixture tends to slip into the next eddy or else spill out into the open sea on the surface above the Gulf Stream. In the Bay of Fundy the high tides also facilitate mixing.

The result of the mixing is that the stratification or appearance of different layers of water at different depths which is typical of most waters at these latitudes, does not occur to the same extent in the waters adjacent to the continental shelf of North America. The surface layers are kept so cool even at the height of summer that temperature conditions approaching those of the far north are produced in shallow waters. Up to a point, cool water is more favourable to marine life than warm water. This is because heat tends to disintegrate and convert, largely into gas, the unicellular life which forms the basic food supply of marine animal life. Cooler waters retard decay, and mixing over

the Banks creates a quite thick body of water having a temperature suitable for pelagic flora.

Mixing and the constant movement of the seas bring a steady supply of mineral foodstuffs to the marine plants which, of course, lack locomotive organs to go in search of their own food. The Labrador Current is rich in leachings from the western plains. In conjunction with the St. Lawrence and other rivers, it provides a continuous flow of the wide variety of mineral nutriments which marine plant life requires.

Plant life in the sea is confined to the upper layers where there is adequate light for plants to carry on photosynthesis. At the same time there is a general downward movement of plant life, either living or dead, and hence a steady transportation of mineral elements away from the surface layers. Because the Grand and other banks are close to the surface of the water, quantities of the sinking marine life are brought back to the surface layers from the shallow floor of the sea toward which they have settled. This elevation may take place normally with the upwelling and almost continuous mixing of the waters, or it may occur during storms. At all events the brighter layers of water near the surface over the banks never lack for nutriment, whereas in the open sea there is only a meagre supply of nutriments because there is no steady elevation of foodstuffs from the depths to which creatures previously at the surface have sunk. It is for this reason that the open seas are relatively barren of fish life and that almost all the world's commercial fishing is conducted at depths of less than 100 fathoms.

In short, over these banks there is a thick layer of water the temperature of which is suited to prolific marine life, there is a steady supply of nutriments from the nearby land, and there is continuous replenishment of these supplies by means of elevation from the relatively shallow banks to the upper layers where light is sufficient for metabolism. All these factors work together to

encourage rich marine pastures just as, on land, fertile soils coupled with suitable temperatures and ample sunlight create lush vegetation. There is, of course, some decline in marine populations during the winter due to lack of sunlight, but comparatively little fishing could be carried on at that season of the year in any event due to the severity of the weather on the surface. Under the very favourable geographic and climatic conditions of this area, the pastures recover so quickly in the spring and the fish propagate so rapidly that conservation is never a problem.

Geographic factors favouring the fishing industry off Canada's eastern shores are not confined to the sea itself. Relatively low temperatures throughout the year make it easier for the fish to be dried and salted before spoiling. Cold winters provide a cheap supply of ice for use on the schooners, trawlers, warehouses, and freight cars engaged in the fresh fish trade. The adjacent land has numerous inlets which serve as harbours for the vessels. Along the shores of these inlets the fish are dried. The nearby forest provides cheap material for boats, storage sheds, barrels, casks, and domestic fuel. The land is inhospitable and on the whole ill suited to agriculture. Though this is a serious disadvantage to the economy of the Region as a whole, it has forced the inhabitants to look to the sea as a source of livelihood.

Against these advantages must be placed certain serious geographic disabilities connected with fishing in general and this area in particular. The basic geographic difficulty is that a comparatively isolated area produces a perishable product for sale in distant markets. Obviously the article needs to be rendered less perishable and less bulky before being sent abroad. The flesh of any fish or animal goes bad either because of autolysis or on account of the activity of bacteria operating from outside the creature.[29] Autolysis is an internal structural decay

[29]Macpherson, N. L., *The Dried Codfish Industry* (St. John's: Newfoundland Dept. of Natural Resources, 1935); Fisheries Research Board (formerly Biological Board), *Report* (Ottawa), annual.

arising from the activity after death of numerous substances, called enzymes, whose purpose during life is to ensure the correct working of the tissues. Both bacterial and enzyme action is greatly increased by contamination from outside sources and by warmth in the presence of moisture and certain acids.

Decay can be prevented or at least slowed down by cleanliness, lowering the temperature, reducing the water content, altering the acidity or a combination of these. The commercial methods of preventing decay are chilling, freezing, drying, smoking, salting either dry or in brine, and canning. The ideal method of preservation is one which gives a final product capable of reverting to the original state of the fresh material without loss of protein, vitamins or flavour. Canning most nearly approaches the ideal but is too expensive for a relatively low-priced fish which faces intense competition from meat and fish of the same general type produced close to the markets. Salting, the withdrawal of water from the tissue cells so that autolysis and outside bacteria do not have a favourable environment for activity, is the common method of preserving fish in the Acadian-Appalachian Region. Fundamentally, salting is a means of offsetting the perishability of the product and the relative geographic remoteness of the area.

The fact that fishing is physically a hard life is another handicap.[30] The hours are long and the work unpleasant especially in the cold, rough, foggy seas of the North Atlantic. Even in summer the risk of injury or of loss of life is great. During the winter, fishing on the Banks is suspended, except by trawlers, and the off-shore fishermen work under great difficulties. The catch is always uncertain both for the industry as a whole and for any

[30]Fielder, R. H., "Fisheries of North America", *Geographical Review*, vol. 30, April, 1940, pp. 201-14; Wallace, F. W., "Life on the Grand Banks", *National Geographic Magazine*, vol. 40, July, 1921, pp. 1-28.

individual ship. Prices in recent years have been erratic and generally unsatisfactory.

Fishing settlements are of necessity scattered along the coast. It is not easy to get the product while it is still fresh to points which have fast rail communication and so the fisherman in the smaller communities is thrown back on putting the fish in the more imperishable but usually less profitable form of heavily salted cod before sale. The land holds forth little promise of producing articles which could sell in competition with the products of other Regions but the few small fertile patches could be used to raise vegetables, meat and dairy products for the fisherman's own use. Unfortunately, the fisherman's outlook has been toward the sea for so long that he has neglected raising his standard of living by gardening or farming. In many cases his living standard is deplorable. Also, in the isolated settlements medical, educational and religious services are inadequate.

In an effort to improve the lot of these fishermen, St. Francis Xavier University at Antigonish, Nova Scotia, has sponsored co-operative ventures in the purchase of supplies and has encouraged domestic handicrafts. The schemes have helped the people economically and have brought new vigour and hope to their lives. Human ingenuity is attempting to triumph over geographic disabilities.

The existence of a plentiful supply of fish along Canada's Atlantic coast is largely the result of geographic factors. The use of this resource is a question of economics. The method of exploitation is comparatively simple.[31] During the period from about March 15 to the end of September over which fishing on the banks extends, schooners of about 135 tons make three trips, each one of which occupies about a month's time. The vessels

[31] Grant, R. F., *The Canadian Atlantic Fishery* (Toronto: Ryerson Press, 1934); Newfoundland Royal Commission, *Report* (London: H. M. Stationery Office, 1933), *passim*.

tend to follow the schools of fishes such as capelin and squid on which commercial fish feed. From each schooner seven to ten small row-boats or dories, each with two men, put out daily. While one man rows, the other pays out a line which has already been baited with frozen mackerel or herring or later in the summer with capelin or squid. Each line consists of a ground-line from which at intervals of about 3½ feet are hung ganglings each two feet long and terminating with a baited hook. The long lines containing from 500 to 1,000 hooks are paid out in various directions from the dories. Periodically each line is lifted. After the fish have been secured, the line is rebaited and the process is repeated. When one area gives any indication of being depleted of fish by the movement of the "school", the vessel moves on.

As soon as possible after the fish are caught they are bled by slitting the throat, otherwise the fish begin to stiffen and lose quality. After being landed from the dories onto the schooner the head, entrails and fins are removed though the liver is retained for the production of oil. The fish is washed several times in clean salt water. Salt is then sprinkled liberally on the cod. The codfish are placed in piles or ketches in such a manner that the brine will drain off and not remain in pockets or hollow spaces. The fish is packed in the hold where it remains in a heavily salted condition until the vessel reaches port. There the fish is sold to merchants and the cure is completed by them.

Instead of catching fish from dories on the banks, many fish are caught from small sail or motor boats within 12 or 15 miles from shore by means of either hand lines, fairly long trawls, or traps. The fish are landed daily and salted "slack" or lightly. Whether the fish are caught on the banks or off shore, the cure is completed by placing them on "flakes" consisting of a frame of lattice work or wire netting placed about 30 inches off the ground so that a good circulation of air is possible. The best

grade of cured fish is produced under the low temperatures of the spring and fall, provided the sun is sufficiently bright to permit the salt to "strike in". High temperatures cause a type of sunburn in the fish and lack of adequate sunshine leads to the decomposition of the outside of the fish, giving it a slimy appearance. The quality of the salt has an effect because salt that is derived from the recent evaporation of sea water, formerly the main source for this Region, may cause a red fungus growth called dun, and rapid deterioration. Malagash salt overcomes this defect. Sunburn, sliminess and dun greatly reduce the selling price of the fish. During the curing process the fish have to be turned often in order to insure an even cure. Also, it is very important that rains and heavy dew be avoided for there is no way of restoring the quality once fish in the process of cure have become wet. When the cure is nearly complete the fish are piled up from time to time and allowed to sweat so that the moisture within the fish can come to the surface and be dried out later in the sun.

Obviously drying in the sun involves considerable skill and risk. Plants for drying fish artificially have been erected. By carefully controlling the temperature and humidity, the fish can be cured in about 48 hours in comparison with the customary three weeks of the older method. Artificial drying can be carried on independently of outside weather conditions, a great deal of labour is saved, and though there is a great deal of discussion of the matter, the quality of the artificially cured fish does not appear to be inferior to sun dried. The main limitation on the use of artificial drying is the fact that the cost of the plant is so high that plants cannot be profitably maintained at the smaller ports where many fish are at present landed. When lower cost plants have been devised it is likely that the entire drying process will be completed artificially as is the case already in Iceland.

The salt fish is sold in Spain, Portugal, Italy, Brazil, Cuba

and the West Indies. Each of these markets prefers a slightly different cure from the others and the merchant or fisherman must know the probable market before he completes the cure. In all of these markets there is a decided shift away from the heavily salted fish which Canada supplies. Canadian fishermen are also experiencing great difficulty in meeting the competition of producers in Iceland and Norway in the distant markets. Foreign fishermen pay more attention to the cures and the tastes of consumers than Canadians do. The governments in both Canada and Newfoundland are attempting to introduce standard grades and to train the fishermen in the best methods of curing but their efforts have been only moderately successful, due mainly to the inertia of the fisherman and the scattered nature of the operations.

The comparative decline in the export of salt codfish has placed more emphasis on the trade in fresh fish and on herring, haddock, and halibut in addition to cod. The basic problem here is to get the fish to the thickly populated areas of central Canada in prime condition. The fish are packed in ice and sent by fast express. But ice does not prevent deterioration; it merely delays the processes of decay which have begun almost as soon as the fish leaves the water. When the fish is delivered in Montreal or Toronto it is still fit for human consumption but is not in a truly fresh condition; it hasn't the real sea flavour that a freshly caught salt-water fish possesses. The family which tries fresh fish does not have its appetite whetted for more. Housewives often overlook fish as an element in the diet. Families in the lower income groups will not buy fish unless it sells at a certain differential below the price of meat. The number of retail stores with adequate facilities for the storage and display of sea foods is small but is not likely to increase because of the seasonal nature of the business, the only periods of heavy sale being Fridays and Lent. Retailers can rarely estimate the de-

mands of their customers accurately and so there are large wastes from spoilage or losses of sales due to lack of merchandise. Finally, transportation by fast express is expensive. In short, it is not easy for the fisheries along the Atlantic shore-line and the continental shelf to overcome the geographic disability of being located beyond an area which juts out from the edge of the continent and which is separated from the thickly populated sections of Canada by a fairly wide stretch of barren rock.

In recent years, especially with the decline of foreign markets, a great deal of attention has been given to the problem of the Atlantic fisheries.[32] In an effort to reduce costs, steam trawlers have been introduced. The trawler, a two-masted steamer, sails to the banks and carries on fishing by hauling through the water a very large conical net which gathers up all the fish within its path. The net is periodically emptied into large water-tight boxes called ponds located on the forward deck of the vessel. From these ponds the fish are sorted out and the commercial varieties cleaned and packed in ice in the hold. The non-commercial varieties are either thrown back into the sea or are used as fish meal. Trawlers make the trip to the banks and return every week or so. They can operate in the winter when the sea over the banks is too rough for dories and can provide a regular supply of fresh fish throughout the year, whereas with the older methods the shore fisheries alone cannot fulfil the needs of the market in winter. The trawlers operate without bait and the catch per man is very high. Thus, in spite of the interest charges on the large and rather expensive vessel, the cost per quintal (112 lb.) is less than by dory fishing.

Needless to say, trawlers are opposed by the fishermen who operate off shore and from the older types of vessels. It is

[32] "The Conditions Necessary for the Revival of the Atlantic Fisheries", Nova Scotia Economic Council, *Report* (Halifax: 1937); *Proceedings of the Nova Scotia Fisheries Conference*, Halifax, 1938; Nova Scotia Royal Commission Inquiry, *Report* (Halifax: 1934).

claimed that trawlers are ruining the livelihood and the investments of the fishermen by lowering the price of fish. It is said too that they are slowly destroying the fishing grounds. Trawlers catch all the fish which happen to be in the path of the net. Fish not directly edible by humans are used for meal or thrown back to die. The food supply of the fishes of commercial value is thus reduced. In defence, the trawlers claim that fish prices have been lowered as a result of international factors of demand and supply over which the trawlers have no control. There is no evidence of depletion and the trawlers typically secure their fish from the lower layers of water which are not fished at all by the traditional methods. Whatever may be the merits and disadvantages of trawlers they are at present heavily taxed and only a few are operating. Trawlers can use their nets only where the ocean floor is smooth.

One proposal for the rehabilitation of the industry is quick freezing. Normally the fish are merely packed in ice as a means of retarding the bacterial activity and autolysis which eventually results in the decay of the fish. Sometimes the fish are literally frozen but the ordinary process of freezing results in the formation of large ice crystals within the fish thus breaking down the cells in the flesh. When the fish has thawed out, decay proceeds very rapidly because the breakdown of the cellular structure has already begun. Under the quick-freezing process cleaned fish are placed in a metal container and, without coming in direct contact with the circulating cold brine, the fish are frozen in 15 to 20 minutes—so quickly that only small crystals are formed. Under this method fish can be kept in prime condition for a much longer period of time and can be placed in an attractive package for sale. The chief limitation on the process is that fish must be kept frozen until ready for cooking. This involves providing the requisite equipment for maintaining temperatures of 10°F. or lower at every stage in the movement

of the fish from the plant to the retailer and eventually to the consumer's kitchen. Work in a quick-freezing plant is not pleasant because temperatures must be kept so low that employees have to take time off to "thaw out".

A few areas in this economic Region have developed specialty products. Herring are caught along the Atlantic coast of Nova Scotia and on the banks. The mature fish are sold fresh, filleted, canned, smoked, pickled, and salted. About 40 per cent by value of all herring caught by Canadians in the Atlantic is secured from a strip of coastal waters about 35 miles long on the north shore of the Bay of Fundy near Passamaquoddy Bay. Here the chief catch is the young herring, the so-called sardine, which is canned and sold all over the world. At one time large quantities of mature herring were caught off this coast with gill nets or weirs and were salted in barrels, smoked, or even used as fertilizer. So many herring were taken that the destruction of the resource was feared, yet no legal action was taken to protect the spawning grounds due to the need of getting the co-operation of both Canada and the United States on any measure of control. The numbers of adult herring were decimated. This made more food available for the younger herring whose numbers so increased that they now show no signs of exhaustion despite the growth of the sardine-canning industry. A new and valuable industry thus came into being because of the rapacity of man. This is a curious illustration of conservation in reverse.[33]

In the relatively shallow waters of Miramichi Bay the smelt fishery is one of the most important in the world. Smelts are frozen and sold chiefly in the United States. On the Gaspé shore cod is cured by a method which is no different in essential principles from that described but which, by using less salt,

[33]Jenness, D., "Canada's Fisheries and Fishery Population", *Trans. Royal Society of Canada,* sec. 2, 1933, pp. 41-6; Huntsman, A. G., "The Wise Use of our Fisheries", *Trans. Canadian Conservation Association,* 1941, pp. 106-14.

results in a flavour which is much appreciated in some markets and hence commands a premium in price. The resources of salmon have been greatly depleted since 1885 but have recovered somewhat in the last decade. Formerly almost every river in the area was well stocked with salmon but the greediness of fishermen and the pollution of the streams by saw- and pulp-mills has destroyed the salmon in all but a few streams. At the mouths of these rivers, especially the Miramichi, the salmon are caught for sale by nets stretched across near their mouths. Up-stream, salmon are caught by hook and line for sport. The government of New Brunswick has leased the exclusive right to fish in certain streams to sporting clubs in order to raise revenue and save the resource from indiscriminate fishing. The interests of these clubs sometimes conflict with those of the commercial fishermen near the river mouth.

By-products of the fishing industry are increasing in importance. In filleting 100 pounds of fish about 67 pounds of waste is secured and this, when dried, yields about 12 pounds of meal which can be fed to poultry and dairy cattle. If used in moderate quantities, the meal increases the output of eggs, milk, and meat without conveying a fishy taste or odour. Filleting has the further advantage of making the fish more attractive to consumers and eliminating the expense of transporting waste. Oil extracted from the entrails of commercial fish and from the entire bodies of non-edible types is used for waterproofing clothing and cordage, and in manufacturing soaps, paints, and leather. From the sounds or swimming bladders of hake and cod is secured isinglass used in pharmacy, in the textile industry and in high-grade adhesives.

The most valuable single by-product, however, is cod liver oil. The livers of cod caught off shore are cooked by steam and the oil which floats to the top is skimmed off. If the livers are fresh, the oil is of the highest quality. The residue is pressed to get

the remaining oil but this is of lower grade. Because fish livers are very perishable, those from cod caught on the banks deteriorate badly before they can be taken ashore and the oil extracted. Preservatives can be used on the livers but the power of penetration of these preserving fluids is so slow that considerable decomposition takes place in the interior of the livers before the oil can be boiled out. When the oil from these livers is extracted, it has an objectionable flavour and odour though its vitamin content is as high as that from fresh raw material. Processes for de-odourizing this oil are now being used.[34]

Though not biologically a fish, lobsters are an important marine resource. The adult lives on the bottom of the sea relatively close to the Atlantic shore of Nova Scotia or the Gulf of St. Lawrence, with only a few in the Bay of Fundy because the waters are too cold there. The young thrive only in the warmer waters at the heads of the bays or around the Magdalen Islands but adults have a more extensive habitat. Adults rest lightly on the tips of their walking legs, the weight of their bodies being largely supported by water. They feed on sea urchins, starfish, worms and crabs. The skeleton of the lobster is on the outside of its body and is moulted periodically as the creature grows. Lobsters are caught in traps called pots or creels made of common house lath nailed on a hardwood frame to form a box about four feet long and two feet square. In each end of the pot is a funnel-shaped net about a foot deep and six inches in diameter at the smaller end. The lobster, a dull-witted but wary creature, is induced into the trap by a herring used as bait. Each trap is weighted to the bottom with bricks and attached by a short rope to a runner or main line at the surface. The ends of the main line, which are about 1,000 feet apart, are

[34]Carter, N. M., "Oil from the Sea", *Canadian Geographical Journal*, vol. 15, December, 1937, pp. 305-13; Fisheries Board, *op. cit.*, 1941; Tressler, D. K., *The Wealth of the Sea* (New York: The Century Co., 1927), pp. 212-29.

marked by buoys distinctively coloured so that each fisherman can identify his own. Traps are set in from 40 to 100 feet of water. The lobsters must be carefully removed from the traps, for their powerful claws may seriously injure a man's fingers. They are marketed canned, or sent alive by shipping in water, mainly to the United States.

The lobster is particularly susceptible to depletion because the eggs are carried around by the female lobster on her body for from eleven to thirteen months before hatching. If such a "berried" lobster is caught and destroyed, propagation of the species is prevented. Young lobsters are defenceless, have no sense of danger and have a great many enemies such as the smaller fishes, crabs and other lobsters. Lobster hatcheries have not been successful because the very young are cannibals and in the crowded conditions of the hatcheries "they eat each other up". The fishery is being conserved by establishing closed seasons when lobster fishing is forbidden, by requiring that berried lobsters be liberated, and by regulating the distance between the laths in the pots[35] so that young, immature lobsters can escape.

Oysters and clams are other marine products of economic importance though not of the fish family. At one time oysters were very important commercially here but the beds were depleted by over-fishing. In the last twenty-five years the Dominion government has been trying to re-habilitate the industry, mainly by encouraging oyster farming in Malpeque Bay in Prince Edward Island, near Buctouche, New Brunswick, and elsewhere. A fully grown oyster will produce about sixty million eggs annually. After fertilization these eggs form an embryo which swims around propelled by a fine hair resembling a tail. After two weeks the embryo enters the spat stage by attaching itself to a clean solid object on the bottom and starting to grow

[35]Templeman, W., *The Life History of the Lobster* (St. John's: Nfld. Comm. of Govt., 1940); Tressler, *op. cit.*, pp. 257-65.

its outer shell. An oyster lives by beating algae and air contained in the water through its gills.

Oyster farming consists chiefly of trying to ensure the best natural conditions for the growth and reproduction of oysters. Old shells are "planted" on the bottom to act as spat collectors. Pollution of the water by sewage is stopped because, although it does not kill the oysters it renders them unfit for human consumption. Rivers and currents are prevented from covering the beds with silt. Enemies, particularly the starfish, are kept away. This creature is sometimes got rid of by mopping the beds with a huge bundle of yarn which entangles the thorny back of the starfish, thus permitting its removal and destruction. Another enemy is the drill, a little shell fish which bores through the oyster's shell like an auger, killing the oyster and living off the meat. The oysters which survive these enemies are removed from the beds by dredges or tongs when they are about four years old and ready for use. The small-sized or "seed" oysters are transplanted to new locations where the water is clear and they have room to grow. Mature oysters are sold canned, in the shell, or husked (shell removed). The production of clams which are dug up from the sand along the sea shore at low tide is small at present, chiefly because Canadians in general have not acquired a taste for them. The industry has possibilities of expansion.[36]

Manufacturing

In the Maritime Provinces manufacturing is largely confined to processing raw materials of the farm, sea and forest before sale. Creameries, fish curing and packing establishments, sawmills and newsprint plants are important. In Nova Scotia there is a considerable iron and steel industry as already explained. Some raw materials, notably raw sugar and cotton are brought

[36]Prytherch, H. F., "Scientific Methods of Oyster Farming", *Scientific Monthly*, vol. 38, 1934, pp. 118-28; Tressler, *op. cit.*, pp. 230-56.

in and manufactured before being sent on for sale elsewhere in Canada. Most of the goods—tea, sardines, sugar, candy, textiles, and steel products—exported from the Region are sent to the St. Lawrence Lowlands. In 1870 the Maritimes produced 13½ per cent of the gross value of all Canadian manufactured goods but by 1935 this proportion had declined to 4½ per cent. The Maritime manufacturers find it difficult to compete with those in the St. Lawrence Lowlands because of their smaller local market, remoteness from the centre of population in Canada, poorer access to many raw materials, and so on.

Recreation

Another industry of importance in the Acadian-Appalachian Region is recreation.[87] Summer visitors come to enjoy the salt-water beaches. Others are lured by the possibility of yachting, fishing for salmon or deep-sea sport fish such as tuna and swordfish, and hunting deer, moose, and even bears which still inhabit some of the isolated parts of New Brunswick and Nova Scotia. Still others are attracted by the Reversing Falls at Saint John, the tidal bore of the Petitcodiac, the unique topography of Roc Percé, the apple orchards of the Annapolis Valley, the rural serenity of Prince Edward Island, the Old World atmosphere of parts of Gaspé, and the places of historical interest scattered throughout the Region. As a tourist centre the area is favoured by being near to the thickly populated centres of New England and New York and having a cool summer climate. On the other hand, American states, such as Maine, in the same physiographic province, have similar attractions and better roads. Besides, the tourist industry is highly seasonal in character. Nevertheless it is important in providing an outlet for farm produce and in giving employment in hotels, tourist camps and service stations during the summer.

[87]Stead, R. J. C., "Canada's Maritime Playgrounds", *Canadian Geographical Journal*, vol. 18, February, 1939, pp. 59-76.

General

The rehearsal of the main economic activities of the Acadian-Appalachian Region—agriculture, mining, forestry, fishing, power, manufacturing, and recreation—fails to convey the true picture of the Region as a whole. Despite the many lines of endeavour carried on, the prosperity of this Region has failed to keep pace with that of the rest of Canada.[88] This Region was discovered and to some extent settled before the rest of the Dominion. Its pioneers—French, pre-Revolution Americans, United Empire Loyalists, Scots, Germans—were of excellent racial stock. It is closer to the markets of Europe, the West Indies, and the most thickly populated parts of the United States than the rest of Canada. It has ample coal and, nearby, plenty of iron, the two articles ordinarily considered to be the bases of advanced industrial development. Finally, it has lumber and agricultural resources.

In spite of these advantages the development of the area has lagged. In 1871 the three provinces of New Brunswick, Nova Scotia and Prince Edward Island, that is, not including those parts of the province of Quebec which are physiographically in the Acadian-Appalachian Region, had 21 per cent of the population of Canada. In 1941 they had only 10 per cent.

The reasons for this development are partly historical. The United States tariff cut off the market which was most accessible from a geographic point of view. Tariffs in other countries reduced the outlets for fish and potatoes, two of the chief staples. The tariff erected by Canada herself has benefited the St. Law-

[88]Canada, Royal Commission on Maritime Provinces Rights, *Report*, Ottawa, 1926; Currie, A. W., *Canadian Economic Development* (Toronto: Thos. Nelson & Sons, 1942) pp. 121-135; Nova Scotia, Royal Commission, Provincial Economic Inquiry, *Report* (Halifax: 1934); Saunders, S. E., *Studies in the Economics of the Maritime Provinces* (Toronto: The Macmillan Company of Canada Limited, 1939); "Economic History of the Maritime Provinces", *Royal Commission on Dominion-Provincial Relations* (Ottawa: 1940).

rence Lowlands far more than the Maritimes for, as we shall see, the former Region has considerable geographic advantages in manufacturing. The Acadian-Appalachian Region juts far out from the edge of the continent. Most of it is separated from the large market in the Lowlands by a relatively wide strip of barren rock and from the Prairies by a further barrier north of Lake Superior. Improvements in transportation have enabled better quality, more cheaply produced goods from the Plains to displace the agricultural products of Acadia. The Maritimes have also suffered adversely by the shift in dietary habits from salt to fresh fish and other products. Similarly, they were put at a disadvantage by the change from wooden sailing vessels which could be built easily from local raw materials in the harbours along the coast to the iron and steel steamship in the construction of which the British yards had great advantages. Once the decline in manufacturing began and emigration to New England and to other parts of Canada started, it tended to be progressive, for new factories were established in the growing centres of population rather than in the declining ones.

In short, geographical factors coupled with historical ones have led to a comparative retrogression of this Region. The drabness of the general picture is relieved by the relative prosperity of the districts producing apples, potatoes, and fox furs, and by the growth of the tourist industry. It is brightened too by the fact that emigration has added valuable members to the educational, banking, and political life of the rest of Canada.

Chapter III

ST. LAWRENCE LOWLANDS

ST. LAWRENCE LOWLANDS extend, in Canada, from near Quebec city westward to Lake Huron and the Detroit River, a total distance of 600 miles. From a purely physiographic viewpoint the Lowland is divided into three sections. The first of these begins as a narrow strip on either side of the St. Lawrence River in the vicinity of the city of Quebec. The strip broadens, particularly on the south side of the river, until it is about 120 miles wide at Montreal. The section continues up the St. Lawrence River about 100 miles to Brockville and up the Ottawa River 150 miles to Renfrew. North of the St. Lawrence and Ottawa rivers the Lowland is bounded by the Canadian Shield itself and between Renfrew and Brockville by a projection of the Shield known as the Frontenac axis. To the east and south the boundary is the Acadian-Appalachian Region and the forty-fifth parallel.

The second section begins at the southwestern edge of the axis along a line drawn roughly due west from Kingston at the foot of Lake Ontario to the south end of Georgian Bay. This section extends to the Niagara escarpment, an abrupt eastward-facing outcrop of limestone and sandstone 250 to 350 feet high. The escarpment runs from the Niagara peninsula northwest to the rocky tip of Bruce or Saugeen peninsula and, after being submerged by Lake Huron, shows up again in the northward-facing cliffs of Manitoulin and adjacent islands. The third section lies above the Niagara escarpment and stretches to Lake Huron and the St. Clair and Detroit rivers. This last section is physiographically an extension of the great central plain of the United States.

Though physiographically divided into three sections, the Region is a unit from an economic standpoint. The resources of the three sections are similar, the climate is substantially the same and the economic problems identical. Consequently the three sections are here dealt with as one economic-geographic entity. The Region as a whole comprises an area of more than 35,000 square miles and has at least half the population of Canada.

Topography

The general appearance[1] of each of the sub-regions is that of a gently sloping plain of fertile land. The sections differ from each other chiefly in their altitudes.

The most easterly section has a general elevation of from 100 to 300 feet above sea level except for eight Monteregian hills of which the westernmost, Mount Royal at Montreal, is typical. Mount Royal is a circular hill occupying only a few square miles of territory and rising abruptly about 700 feet above the surrounding country. Because of its shape and its composition of igneous rock, it is believed to be the neck or plug of an ancient volcano. Most of the sides of the volcano and any lava and ash which it erupted have long since been worn away by natural agencies. All the Monteregian hills are prominent but economically unimportant features of the landscape. The floor of the plain of this sub-region blends into the hilly district of the Appalachians to the south and east. It is marked off from the Canadian Shield to the north by a rocky escarpment rising to

[1]Atwood, *op. cit.*, pp. 183-234; Dagenais, P., "Le Milieu Physique", in Minville, E., *ed.*, *Montréal Économique*, Montreal, 1943, pp. 37-94; Malcolm, W., "Geology of Canada", *Canada Year Book, 1936*, pp. 18-28; Putnam, D. F., and Chapman, L. J., "The Physiography of South Central Ontario", *Scientific Agriculture*, vol. 16, May, 1936, pp. 457-77; Sutherland, J. C. *The Province of Quebec, Geographical and Social Studies* (Toronto: Thos. Nelson & Sons, 1931); Vézina, F., "La Region du Saint-Laurent", in Minville, *Nôtre Milieu*, Montreal 1942, pp. 53-78; Young, *op. cit.*, pp. 68-82.

considerable heights in places. The boundary between this section and the Frontenac axis to the west is not abrupt from the standpoint of altitude but is clearly marked by the change from broad stretches of fertile soil to crystalline rock with isolated patches of soil.

The second division of the St. Lawrence Lowland is also plain-like. It rises, in places abruptly, from Lake Ontario which is 246 feet above sea-level to altitudes of nearly 1,000 feet inland. The northern boundary of this sub-region is shown by a drop of 50 to 100 feet to the surface of the Canadian Shield. The western limit is set by the Niagara escarpment which is a distinct feature of the landscape from Niagara Falls to the northern tip of the Bruce peninsula. In the Niagara peninsula the escarpment rises abruptly 300 feet above the plain. To the northwest the escarpment itself is not so steep but it forms part of a strip of ground rising rapidly in a series of elevations to a total height of nearly 1,000 feet above the flat country to the east.

The third section lies between the top of the escarpment and lakes Huron and Erie. On the whole the land surface slopes down gently to these lakes which have elevations above the sea of 581 and 572 feet, respectively. Throughout all these sub-regions the general plain-like character of the terrain is modified locally by low hills, broad river valleys and gently rolling land.

Geology

The geographical structure of the St. Lawrence Lowland consists fundamentally of nearly horizontal strata laid down on the hard rocks of the Canadian Shield. As already explained, the oldest rocks in Canada are those of the Shield. Beginning with very early times, these ancient rocks were eroded by water and the detritus placed in layers or strata in the surrounding ocean. From time to time parts of the Region were elevated

or depressed by movements of the earth's crust and the seas retreated or advanced. These movements did not affect the entire Region at the same time nor to the same degree. At any particular time and place the strata which were laid down vary with the degree of elevation, the general nature of the adjacent land, the depth of the water in which the deposits were placed, the climate, the character of the animal life of the period, the length of time involved, the geological conditions subsequent to the deposition and so on. The result is that each of the strata has certain characteristics. By studying the texture of the rocks, the type of fossils they contain, their sequence with respect to adjacent beds and so forth, geologists have been able to reconstruct the history of the Region.

The details of geological history are of interest to the economic geographer only in so far as they explain how the existing landscape and present economic resources came into being. It is sufficient for our purposes merely to point out that, generally speaking, a number of stratified rocks were laid down one upon the other. Due to the local changes just mentioned, a complete series of all types of strata is not present in any single area and some of the strata which may have existed at one time have since been eroded. Because the strata were deposited on the gently sloping sides of the Shield, they dip away at low angles from the edge of the Shield like the layers of an onion around a central core. The strata succeed each other with considerable uniformity. Although local warpings were sufficient to cause the seas to advance or retreat over extensive areas, they were not so catastrophic as to cause wide unconformity. In the Montreal and Ottawa districts there was some faulting of the strata and penetration by igneous material as evidenced by the Monteregian hills but in the main the strata have been relatively undisturbed by diastrophism subsequent to their deposition. Most of the strata are composed of limestone, shale, or sandstone.

When suitable climatic and geographic conditions prevailed, salt, gypsum and petroleum were deposited.

The chief alteration in the character of the stratified formations since their formation has been their gradual rise from the sea. The Canadian Shield seems to have risen slowly lifting the strata along its edges with it. As soon as the rocks had risen above the sea, they were attacked by erosive forces such as water, vegetation, and chemical agencies. Naturally these forces operated for the longest periods of time on those strata which rose first and these were, generally speaking, the ones near the core of the Shield. As the elevation of the land continued, the lower strata near the Shield were worn away as were the more recent rocks farther away from the Shield. The various strata were thus exposed at the surface like the layers of an onion are displayed when one cuts across its grain with a knife. As one moves out from the Shield the oldest strata outcrop first and the more recent ones are displayed farther away—in the Niagara escarpment, for example. There is, of course, a good deal of variation from the general pattern.

In the Quaternary or Pleistocene period of the Cenozoic era a continental ice-sheet over-rode the entire Lowlands. This ice-sheet pushed its way from its centre in the Ungava peninsula to an advanced limit somewhat south of the present-day lakes Ontario, Erie and Michigan. The cause of the climatic conditions creating the ice-sheets is still a matter of dispute among geologists. A satisfactory explanation is particularly difficult. An acceptable theory must explain why smaller glaciers had previously existed in earlier periods in other parts of the world. It must also show why the huge ice-sheets were formed at this particular time rather than at some other and why they were confined chiefly but by no means entirely to North America and Europe, with almost none in the huge northern expanse of Asia. The theory must also make clear why the period of

glaciation was not continuous but was broken up into episodes with inter-glacial periods of varying duration. There are hypotheses based on the fact that the land may have been from 1,000 to 2,000 feet higher in elevation than at present, on the shifting of the axis of the earth, and on the differences in the amount of water vapour and carbon dioxide in the atmosphere. None of these hypotheses is wholly satisfactory.

At all events, the amount of change in the climate necessary to bring about glaciation on a continental scale has probably been exaggerated. All that was needed for glaciation was that the snowfall be enough more than it is to-day or that the temperature be enough lower than at present so that the snow of one year was not quite all melted before the snow of the following year began to fall. In this way, over the centuries, snow would gradually accumulate. At last the snow would become consolidated into ice by its own weight. As snow continued to pile up, the weight of the accumulated mass would cause the ice to spread and creep outward. The ice would continue to advance as long as these climatic conditions persisted and the forward movement of the ice exceeded the amount lost by melting along the frontal edge, or tongue, of the ice. The ice would begin to retreat when melting exceeded the rate of advance. In short, the appearance, advance and retreat of glaciers need not have been accompanied by climatic conditions radically different from those of the present.

As the glacier moved slowly over the rocks of the Canadian Shield and the adjoining strata, it removed the top-soil and scratched the basal rock though rarely to any great depth. The glacier pushed loose soil and rocks ahead of it as it moved slowly along. Often it froze around blocks of rock beneath it and lifted them from their positions. The ice with rocks frozen solidly within it scratched or rasped the underlying rock. The rocks were rubbed against each other under great pressure and

thus worn down flat on one side. There was not one but four main glacial invasions separated from each other by periods of relatively moderate climate leading to the retreat of the ice face and then followed by colder weather and a further advance. The succeeding glaciers chiefly re-worked the material that had been previously eroded and so the erosion of the surface was not as deep as might have been expected. In the main, pleneplanation, that is, reduction of the area almost to a plane or level surface, had been completed by water and chemical agencies before the glaciers began their work. In the thickly settled parts of Canada continental glaciers are more important for their work of deposition than for their erosive action, though in the Shield the reverse is true.

Glaciers deposit either moraine or glaciofluvial formations. When the continental ice-sheets retreated, they dropped some of the material which they contained at the time in an unconsolidated or haphazard way on the surface of the earth beneath. These moraines are less common in the Lowlands than they are in the Shield and Acadian Regions. Glaciofluvial formations consist of detritus laid down in orderly fashion by streams and lakes. Rivers flowing underneath or washing out from the edge of the glacier sort the gravel, sand and silt according to size with the heaviest material at the bottom and nearest the point where the speed of the stream begins to slow down. The finer material is carried farther away, before dropping to the bottom of the now slowly moving stream.

The most important glaciofluvial action took place in the pro-glacial lakes along the southern front of the slowly retreating ice. Once the ice-sheet had withdrawn behind the height of land which at present divides the streams flowing into the Ohio and Mississippi from those running into the Great Lakes, water from the melting ice was dammed up between the height of land and the ice. As the ice continued to melt, the glacial lakes grew

in size. The geological history of these lakes was complicated by the retreats and advances of the ice edge, the shifting of the outlets draining the lakes, and the slow elevation and tilting of the St. Lawrence and Shield Regions as the ice melted away and its weight was removed. The position and extent of these lakes is indicated by beaches and wave-cut terraces, sometimes as high as 600 feet above the level of the present lakes. The shifting margin of the ice acted as a dam across the natural lines of drainage and the gradual uplift of the land cut off other outlets. Thus some outlets had to be abandoned and others secured. There was a succession of lakes each with unstable boundaries, varying outlets, and a comparatively short life. By the end of the Pleistocene period the continental ice-sheets had disappeared and the lakes formerly at the front of the glacier had shrunk to the size, position and levels of the present Great Lakes. Because detritus was deposited on the level or gently undulating lake-bottoms there is little derangement of drainage systems in the Lowlands and, with the exception of Niagara Falls, there are none of the rapids and few of the swamps which are commonly associated with glaciated areas.

Toward the close of the Pleistocene period when the ice was still retreating and the glacial lakes still in existence, an arm of the sea occupied substantially all the present Lowland east of the Frontenac axis. In this basin, which was at least 500 feet deep, sand, silt and clay was deposited as they were in the glacial lakes themselves. Eventually the uplift of part of the Shield and the adjacent basin brought about the partial withdrawal of the arm of the sea but the lower St. Lawrence Valley beyond Quebec city was left in its present drowned condition.

The depositions of the continental ice-sheet had an important effect on economic development. The most common glacio-fluvial material deposited was clay which was formed by the grinding together of rocks by the ice to form a fine powder.

These clays to-day constitute the most fertile soils of the Region. In places sand and gravel were laid down beneath the glacier. These now provide a cheap supply of construction and road-building materials. In a few locations the sands form the basis of specialized types of agriculture. The glaciofluvial deposits do not contain any minerals of importance. Mineral wealth is tapped only at places where the more ancient rocks outcrop at the surface like the limestone and gypsum of the Niagara escarpment, or where they can be reached by drilling through the glacial deposits to the salt, natural gas and petroleum beneath. Geology has pre-destined the area to agriculture rather than to mining.

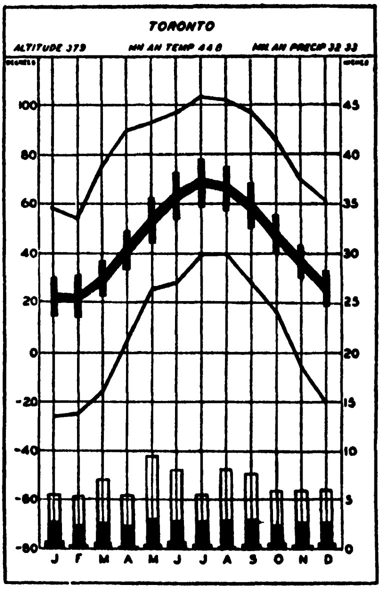
Climate

The St. Lawrence Lowlands have, on the whole, a fine type of climate.[2] The cyclonic storms determine the weather—the daily changes of temperature, precipitation, humidity, and wind direction. The climate which is the generally prevailing or typical weather, is conditioned by the fact that the Lowlands are situated toward the interior of the continent remote from the tempering influences of the oceans. On the other hand, extremes of temperature are moderated somewhat by the presence of the Great Lakes which nearly surround parts of the Region.

Leamington, in the extreme south of Ontario, is the warmest spot in the Region. It has an average temperature during the three coldest months of 26 degrees Fahrenheit and a summer average of 69 degrees. The average length of the frost-free season is 216 days. Further inland, in the peninsula of Western Ontario, temperatures decline slightly due to remoteness from

[2]Koeppe, *op. cit.*, pp. 159-69; Morwich, F. F., "Relation of Soil Types to a Crop Programme," *Agricultural and Experimental Union Report* (Ont. Agric. Dept.: 1937), pp. 25-30; Putnam, D. F. and Chapman, W. J., "The Climate of Southern Ontario", *Scientific Agriculture*, vol. 18, April, 1938, pp. 401-46.

the Great Lakes, increased elevation and, to a slight extent, to more northerly latitude. Decline in temperature is also experienced as one goes eastward from the Great Lakes. At Toronto mean winter and summer temperatures are about three degrees cooler than at Leamington. Montreal is 13 degrees colder in winter and two degrees cooler in summer than Leamington, while



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Quebec city is fifteen and two degrees cooler on the average. The length of the frost-free season declines to about 168 days at Montreal and 135 at Quebec city.

The average annual precipitation at Leamington is 28 inches. This increases to 32 inches at Toronto and over 40 at Montreal and Quebec. Snowfall also increases as one progresses down

the Ottawa and St. Lawrence valleys and averages nearly 150 inches (equivalent to 15 inches of rain) annually at Quebec city. Much of the snow melts away before a subsequent fall of snow and the remainder settles down so that not more than four or five feet is ever on the ground at any one time. Precipitation is evenly distributed throughout the year. It rarely varies more than ten inches above or below the long-time annual average. Thus there is never any danger of drought, though occasionally crop yields are lower than normal due to unusually wet or exceptionally dry conditions. Such a variety of crops is grown, however, that conditions unsuitable to one crop may favour another. As the farmers here say: "There's always a good crop of something." On the whole, climatic conditions in the St. Lawrence Lowland are favourable to agricultural activity.

Agriculture

The agriculture of the St. Lawrence Lowlands is diversified throughout the Region, with various degrees of emphasis being placed on different products in the smaller sub-regions. Almost every farmer raises a number of different articles—wheat, oats, barley, milk, butter, beef, hogs, poultry, wool, vegetables, fruit, and so on—either for sale or for his own use. In different parts of the Region one or other of these articles may predominate but a variety of crops is grown in every area and on almost every farm.

"Seldom are [specialized] areas well defined and in no instance will one find all of the farmers in a given area producing the kind of product for which the area is known. The dairy farm may be found cheek by jowl with a farm the main income of which is derived from growing potatoes. Nor is the entire income of the dairy farm itself derived from the sale of milk and dairy products. Generally speaking, if half of the income came from this source it would be a representative average figure and

the other half of the income might come from one other major, or half a dozen minor, farm enterprises. The farmers in Oxford and Dundas counties in Ontario, generally considered as dairy farming counties, are far from being entirely dependent upon dairy products. Not only will such farmers have other sources of revenue apart from the dairy herd, but many will not be engaged in dairy farming at all."[3] Mixed farming is typical in Quebec too.[4]

There are several reasons for this diversification. First of all, the climate and soils allow it. This is not to suggest that the Region has a wide range of temperature and rainfall, but on account of differences of altitude and position with respect to the Great Lakes, there are climatic variations from the general pattern great enough to allow the commercial production in favoured areas of a few articles which cannot be produced in good quality over the Region as a whole. Similarly for so small an area the soils[5] are unusually varied—loams, gravels, sand, heavy

[3]Coke, J., "Farm Organization in Eastern Canada", in Booth, J. F., *ed., Economic Organization of Canadian Agriculture* (Ottawa: Canadian Council of Agricultural Economists, 1940), p. 81; See also Filion, G., "L'Agriculture", in Minville, *op. cit.*, pp. 133-51; McArthur, I. S., "Farm Organization in Southern Ontario", *Economic Annalist,* vol. 8, August, 1938, pp. 55-7; "Types of Farming in Canada", in Booth, *op. cit.*, pp. 57-80; Taylor, G., "Climate and Crop Isopleths in Southern Ontario" *Economic Geography,* vol. 14, January, 1938, pp. 89-97; Whitaker, J. R., "Peninsular Ontario; a Primary Regional Division of Canada", *Scottish Geographical Magazine,* vol. 54, September, 1938, pp. 263-83; "Agricultural Gradients in Southern Ontario", *Economic Geography,* vol. 14, April, 1938, pp. 109-20.

[4](Translation) "On a typical farm of the St. Lawrence Lowlands, one finds a little of everything: fields of grain, forage crops for the winter and pasture for animals, a few acres of potatoes, a vegetable garden and almost always a little orchard, frequently a sugar shanty; the big stable will shelter 2 or 3 horses, a dozen milch cows, 7 or 8 sheep and as many hogs; besides you will find a hen-house with 50 to 100 poultry." Filion, *supra*, p. 141.

[5]Chapman, L. J., and Putnam, D. F., "The Soils of South Central Ontario", *Scientific Agriculture,* vol. 18, December, 1937, pp. 161-97; Chapman, "Adaptation of Crops in Ontario", *Canadian Geographical Journal,* vol. 24, May, 1942, pp. 248-54; Putnam and Chapman, "The

(Continued on next page)

clay. Each type is especially suited to a particular product. This variation is the result of glaciation.

Equally significant as a factor favouring mixed farming is that the farmer, by raising a number of different articles, is able to make fairly complete use of his own time and that of his horses and machinery. To take a simple example, work in the sugar bush begins in the spring after the winter work such as cutting wood for fuel has been completed but before anything can be done on the land. The equipment needed for the production of maple syrup on a small scale is not expensive. Cheap fuel can be used. The land on which the trees grow does not otherwise produce a cash income. To be sure, the work is hard and the hours long but any income from sale or home use of the maple products is so much clear profit since the labour involved would otherwise be idle. Similarly, other operations on the farm are synchronized. The farmer plans his work so that the task of preparing the seed-bed and finally seeding one crop is followed by seeding another. By the time seeding is complete some crops are ready for cultivating. Before long, haying and then harvesting the field crops begins, followed by threshing and fall ploughing. It is never possible entirely to prevent the coincidence of two operations in point of time but many operations can be postponed a few days without substantial loss. The general policy of integration so as to obtain full use of productive resources is fairly definite.

Another factor leading to diversification is the necessity of maintaining the fertility of the soil. It has been known for many years that the continual growth of the same crop on the same plot of land eventually results in reduced yields. It is

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Physiography of South Central Ontario", *ibid.*, vol. 16, May, 1936, pp. 457-77; Jarvis, T. D., "Soil Studies in relation to Land Utilization Research", *ibid.*, vol. 16, February 1935, pp. 278-96; "The Fundamentals of an Agricultural Research Programme", *ibid.*, vol. 12, October, 1931, pp. 92-114; Morwich, *op. cit.*

important to note, however, that soils are not to be regarded as kinds of reservoirs from which plants steadily draw nutriment so that eventually, when the reservoir is drained dry, the soils become sterile. At the "world's most famous field" at Rothamsted experimental station in England, wheat has been grown on one plot without manure or artificial fertilizer every year since 1839. In recent years the yield has kept at about 10 bushels per acre while adjoining well-manured plots produce about 25 bushels. On all plots the presence of weeds markedly reduced yields.

The fact is that soils are not static reservoirs but dynamic organisms. Their character is constantly changing as a result of the activity of micro-organisms on the soil particles, the decay of plants growing upon it, the burrowing of earthworms and many other factors. Moreover, it is known that plants make different demands on the mineral elements in the soil. By planting crops with different nutritive requirements, the demand for any one mineral is sufficiently intermittent to permit the bacteria and other agencies which create fertile soil to restore the soil, partially at least, to its original fertility. Even more significant is the fact that certain crops add to the soil elements which are of great value to succeeding crops.[6] The most important crops in this respect are clover and alfalfa which absorb nitrogen from the air and concentrate it in nodules about their roots. By ploughing under the roots and stubble of these hay crops at the end of the season a large, cheap, and easily usable supply of nitrates is made available for some other crop in the rotation.

A proper rotation of crops can result in large crops year after

[6]Heimpel, L. G., "Possibilities of Improvements in the Mechanization of Eastern Canadian Agriculture", *Proceedings of the World Grain Exhibition and Conference* (Regina: 1933), pp. 386-96; Hopkins, E. S., and Hopper, W. C., *Crop Rotations and Soil Management for Eastern Canada* (Dom. Dept. Agric., 1930); Wright, L. E., and Hammond, H. S., *Manures, Fertilizers: their Natures and Function and Use* (Dom. Dept. Agric., 1937).

year. Large crops per acre are a prerequisite of profitable farming. The expenses of cultivation, seeding, and to a considerable extent the costs of harvesting and threshing are on a per-acre basis. Total costs vary with the number of acres sown rather than with the number of bushels reaped. The cost per bushel is arrived at by dividing the cost per acre by the average number of bushels per acre. Obviously larger yields per acre mean lower costs per bushel. This is vitally important to the farmer because grain is sold at so much per bushel. Even when the grain is sold indirectly in the shape of livestock or dairy products, the cost per bushel is significant. The only chance a farmer has of making a profit lies in keeping down his costs per bushel below the selling prices per bushel. The easiest way of doing this is to increase yields per acre, though he must also watch costs per acre and costs of marketing. Crop rotation is an important means of keeping yields up and costs per bushel down.

Crop rotation has the further important advantage of destroying weeds which have become a positive menace throughout the Lowlands. Weeds are eliminated by inter-tillage, or cultivating between the rows of corn, potatoes, and other hoe crops. Some crops such as heavy hay or buckwheat smother out certain types of weeds. Others like barley may be cut before the weed seeds mature and then, by ploughing or summer-fallowing the stubble, the weeds can be kept under control. Crop rotation also tends to keep down insect pests and fungus diseases. A variety of crops provides feed for animals and these in turn produce animal manure which is ordinarily the best and cheapest kind of fertilizer.

In planning the rotation the farmer must watch the trend of prices. There is no point in growing rye after a crop of wheat if the rye cannot be sold at a price high enough to cover the costs involved. It might be better to grow wheat for two years in succession because, although the yield of wheat in the second

year would normally be less than in the first, the net income might be more with two crops of wheat than with one of wheat and one of rye.

Of course crop rotation must be accompanied by good tillage practices. If the heavy clay of the Lowlands is cultivated while it is very wet, it forms clods which become very hard when they dry out. Improperly tilled land may, in fact, become so hard in dry periods that crop yields will be very low. Ploughing is a fine art in which some farmers take great pride. Sub-surface or tile drains are often necessary to drain wet parts of the fields, increase the yields on these spots and permit seeding or harvesting of the entire field at the same time. Provided the ground is properly tilled and drained, crop rotation will increase yields, keep down weeds and pests, and add to the supply of animal feeds. In order to secure the benefits of crop rotation, the farmer must diversify his production.

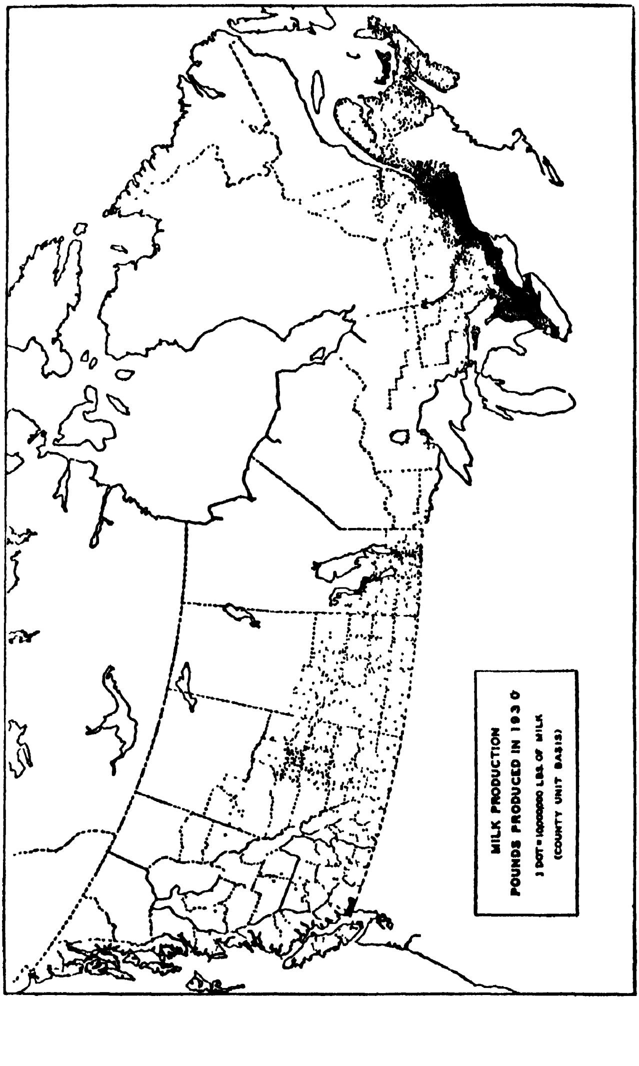
Diversification of agriculture in the St. Lawrence Lowlands is followed also because of the need for a stable income. When a farmer produces only one crop he is subject to all the vagaries of the selling price of that article. Should the price be depressed he may suffer severely. On the other hand, if he produces many crops he has protected himself against the drastic decline in the price of any one of them. He has not put all his eggs in one basket.

The final reason for diversification is historical. The earliest settlers in this Region did not have cheap means of transportation. They could not specialize in the production of one product for they had no way of sending it cheaply to the markets of the world or of economically bringing in the other articles which they required. They were, therefore, thrown back on supplying their own needs and so had to raise a variety of products or go without. Steadily through the years the emphasis has shifted toward producing one particular commodity for sale rather than

a variety of products for domestic use. Nevertheless, the earlier habit of self sufficiency has persisted, especially in Quebec. In brief, for reasons which are geographic, economic and historical in nature, agriculture in the Lowlands is diversified.

In view of this diversification it is difficult to select one article on which primary emphasis is laid, but if one must be chosen it would probably be milk and other dairy products.[7] Dairy cattle thrive where nature provides tender nutritious grass throughout the year as in New Zealand. This necessitates a fairly cool, moist summer and a winter that is not too cold to stop plant growth. Rain is necessary at all seasons in order to prevent the grass from drying up and to provide the cows with ample drinking water. In the St. Lawrence Lowlands these conditions are present only in the spring and early summer. Later the growth of grass diminishes due chiefly to the tendency of herbage to mature and go into a more or less dormant stage. Sometimes, too, pastures dry up because of lower than average rainfall, or high evaporation on the hot summer days. Thus the amount of natural outside pasturage falls off until in winter it is non-existent. To maintain milk production, in the fall grain is fed to supplement the pasture and during the winter the cattle are kept in stables and fed straw with smaller amounts of more nutritious, concentrated feeds like oats, turnips, mangels, and especially ensilage. Although corn will not mature in the Lowlands except in a few climatically favoured parts of Ontario, it can be harvested while it is still partly green, cut to pieces by machinery, and stored in silos. If properly packed in the silo, it will retain its luscious nutriments until ready to be fed. By this method a succulent, palatable

[7]Leitch, A., and Neale, J. C., *Farm Management—Dairy Farming in Western Ontario* (Toronto: Ont. Agric. Dept., 1920); Leitch, A., *Farm Management—Beef Raising and Mixed Farming in Western Ontario and Dairy Farming in Eastern Ontario* (Toronto: Ont. Agric. Dept., 1920); Whitaker, J. R., "Distribution of Dairy Farming in Peninsular Ontario", *Economic Geography,* vol. 16, January, 1940, pp. 69-78.



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and digestible "salad" diet is supplied to the dairy cattle at all seasons. The result of these good farming practices is to maintain the output of milk at a high level of quality as well as quantity throughout the year[8] and thus offset some of the shortcomings of the climate as far as dairy cattle are concerned.

Dairy production is assisted in this area too by the presence of a large and well-to-do consuming population in the cities. Milk is a highly perishable product and if it is to be sold in a fresh condition it must be produced relatively near to the point of consumption. Of course, milk can be hauled in refrigerator cars and trucks but refrigeration is expensive and farmers in districts remote from the cities must put milk in a less perishable and more highly concentrated form like butter and cheese before marketing. There is some tendency for the various dairy products to be produced in concentric rings about the centres of population. Whole milk is produced nearest the city and then cream, butter, cheese, evaporated and condensed milk, and finally beef cattle are raised on the most remote areas. Obviously the pattern will not be applied at all rigidly and there is a very considerable amount of overlapping of the different products. Nonetheless, the general pattern is clear in the Lowlands.

Like other types of farming, dairying faces problems of production and marketing.[9] Fodder for winter use has to be grown, harvested, stored and fed at very considerable expense in labour and the cost of maintaining machinery and buildings. If milk is to be produced at low costs it is essential that this fodder be grown as cheaply as possible and that it be fed so as to yield a large amount of high-grade milk. Hence, the better farmers pay considerable attention to the diets of their cows and raise only

[8]Hopkins, E. S., and Ripley, P. O., *Silage Production* (Dom. Dept. Agric., 1936).

[9]Drummond, W. M., "Problems of the Canadian Dairy Industry", in Innis, H. A., *The Dairy Industry of Canada* (Toronto: The Ryerson Press, 1937), pp. 127-212.

pure-bred cattle of good milking strains. In regard to marketing the essential problem is that the cost of distributing the milk to the ultimate consumer is far too high in relation to what the farmer gets for raw milk. An increase in the number of retail distributors merely increases costs because a larger number of wagons, pasteurizing plants, and delivery men have, in the long run, to be paid for. Attempts at reducing the number of distributors lead to charges of monopoly. Efforts at assisting the producer by raising the price of any one dairy product—butter, cheese, or whole milk—break down due to the ease of shifting milk from one use to another.

The foreign trade in Canadian dairy products was at one time very important, absorbing, in 1900, about 37 per cent of the total milk output of the country. This percentage has declined to less than 5 despite a threefold increase in production over the last 40 years. The decline has been due to higher tariffs abroad, the competition of other producing countries, and the unwillingness of Canadian processors to change the types of cheese and butter exported to suit the altered tastes of consumers abroad. The market at home has increased because of a slight growth in the consumption of butter and ice-cream and a very large expansion in the demand for whole milk and cream.

Closely associated with the production of dairy products is the raising of beef cattle. In the summer they are turned loose on natural or improved pastures. They must be supplied with salt and have adequate supplies of water but otherwise they need very little attention while the farmer is busy with other work. In the winter when the farmer has more time to care for the animals, they are fed in barns on straw with small amounts of the more expensive feeds like oats and ensilage. Beef cattle can manage for some time on this relatively poor diet provided they get enough feed to develop bone and keep their health. Before

slaughtering they must be brought into prime condition by feeding them well either on good pasture or in the stall.

The meat resulting from these feeding practices may not always be of the highest quality, but the farmer often finds it profitable to use comparatively inefficient methods because the beef are in the nature of supplementary products to the other articles he produces. Caring for beef cattle does not interfere with other farm work. The animals eat lower-grade feeds which might otherwise be wasted and they consume grass on rough land which it would be difficult to "harvest" by other means. In some cases the farmers do pay a good deal of attention to beef cattle particularly to the raising of baby beef or veal. The animals are carefully tended in order to produce meat of high quality in the shortest possible time and with lowest cost of feed relative to the selling price of the finished beast.

Besides trying to cut down the cost of winter feeding by watching the cost and nutritive value of the animals' diet, some farmers have attempted to improve the quality of their pastures. They use fertilizers, re-seed the land, rotate pastures with tilled crops more frequently than in the past, and divide up the pasture-lands with movable fences allowing the animals to crop each small plot in rotation and only when it has grown a fairly heavy cover of grass.[10] These methods are not generally used, however, due to inertia of farmers and doubt of their profitability under normal price relationships. Because of the amount of land in natural and improved pasture and the importance of hay and grass to the Region, it would seem that further improvement in quality is urgently needed. The output of the better types of beef is encouraged by the government and the meat packers. The former grades the beef and stimulates the consumption of the better

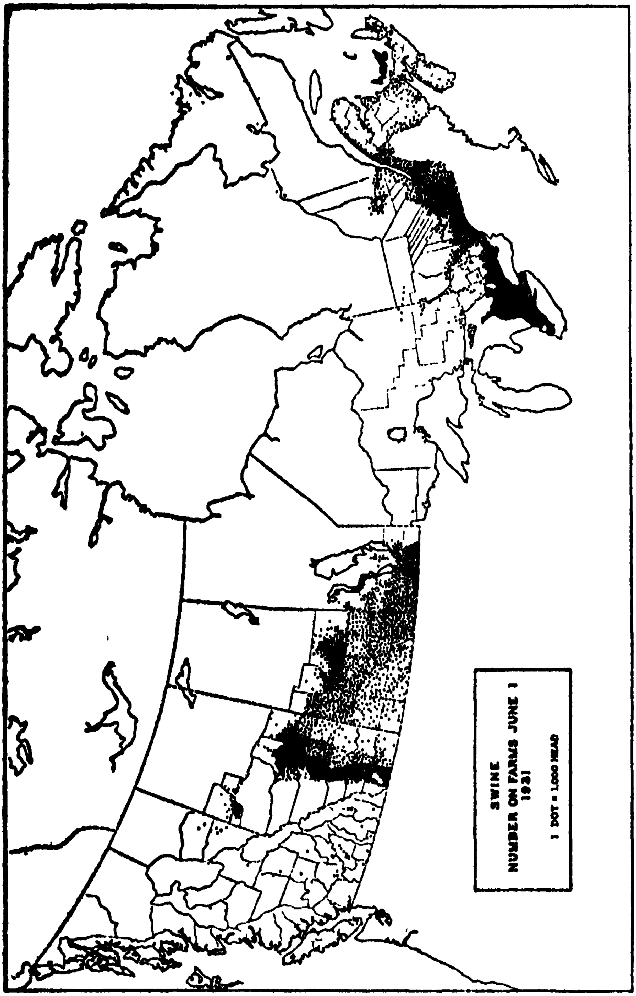
[10] Committee in charge of Pasture Investigations, *Pasture Improvement in Eastern Canada* (Dom. Dept. Agric., 1938); Raymond, L. C., "Improvement of Grazing Lands in Eastern Canada", *Empire Journal of Experimental Agriculture*, vol. 4, January, 1936, pp. 51-60.

quality. The meat packers pay more for "prime steers" and thus reward the farmers for raising superior animals.

For the most part Canadian beef cattle are consumed at home. The market in the United States is cut off by a tariff which quotas authorized by the reciprocal trade treaties have only slightly modified. For many years Great Britain debarred Canadian cattle on the ground that they might bring in the foot-and-mouth disease and infect British livestock. In 1923 the embargo was removed to the extent that Canadian livestock could be imported but they had to be slaughtered within a few hours after arrival. Cattle are not in good condition after their long voyage in cramped quarters aboard trains and ships from Canada. In order to bring them into prime condition before consumption they should be fed for a few weeks in Britain but this is still forbidden. Moreover, ocean freight rates on live cattle are high. Vessels must be specially adapted to the cattle trade and, since they cannot readily be used for other types of cargo, the ships must make the return trip in ballast. Trade with Britain in chilled beef and mutton has never developed in Canada because, despite the advantage of proximity to market, Canadian frozen meat cannot compete on a price basis with meat raised on the open range throughout the year in Australia and the Argentine.

Hog raising is an important part of the mixed farming of the St. Lawrence Lowland.[11] Hogs are fed grain, skim milk and kitchen wastes. There is a tendency, therefore, for hog raising to centre in the more thickly settled rural areas and in dairying districts. In comparison with dairy cattle, hogs need little attention and are usually considered as a by-product to mixed farming. The number of hogs on any farm rarely exceeds ten or

[11] "The Canadian Hog and Bacon Industry", *C.S.T.A. Review*, May, 1936; Reed, F. H., and Wilson, H. E., *Swine Production* (Dom. Dept. Agric., 1940).



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twenty. In fact, it has been stated that one or two of the smaller counties in Lowland Ontario have fewer hogs than individual farmers in the Corn Belt of the United States. In comparison with the typical American product, the Canadian hog is lean because it is fed on oats and barley, whereas the fatter American pig consumes corn, an oily grain. Canadian bacon often enjoys a premium in price on the American market but the tariff keeps out large amounts.

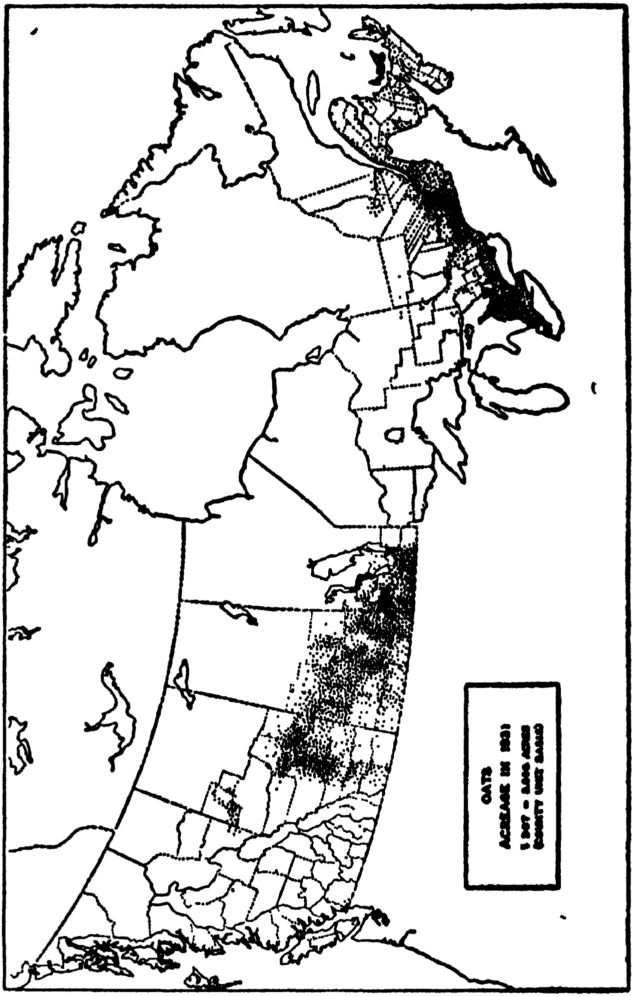
In normal times Britain takes about ten per cent of the total Canadian hog output. This percentage could probably be increased substantially if Canadian hogs were of the type which the British consumer desires, a smooth, evenly developed pig with lean firm flesh, a maximum of bacon and ham cuts and a minimum of shoulder. To raise such a hog in large numbers in Canada is not physically impossible but involves a careful selection of breeds and then close attention to feed rations and feeding methods. In a normal peacetime year Canadian farmers probably lose about one million dollars due to their unwillingness to produce for the British market. The continued failure to take advantage of this situation and of the tariff preference which Britain gives to Canada is due to the farmers' inertia and the fact that in the past hogs have been regarded as a by-product for domestic use and not, under proper management, as an important source of income. A further difficulty is that it is relatively easy to expand the output of hogs on short notice. When prices rise, the number of hogs quickly increases. This reduces the price and discourages continuance in the industry even by the more efficient farmers.

On many farms throughout the Region small flocks of sheep are kept. They provide a supplementary source of income without involving much additional work or expense for stabling and feed. They can subsist on pasture which is poor because of either local deficiency of rainfall, soil infertility, or the presence of

stones. Sheep are excellent for keeping down the weeds and for providing very high-quality manure. Typically the sheep are dual purpose, supplying both wool and mutton. Of course every sheep inevitably produces both but some types are bred primarily for wool as in British Columbia and others chiefly for mutton as in Britain where such meat is eaten to a larger extent than in Canada. Dual-purpose sheep are raised in the Lowlands because they provide sufficient lamb and mutton to fulfil domestic requirements and there is also a good market for wool. Climatic conditions make the raising of this type possible, whereas on the ranges of British Columbia the grass cover is too poor to produce good-quality mutton.

The diversified farms of this Region produce other articles of importance. Almost every farm raises enough vegetables and small fruits (strawberries, raspberries and currants) for its own use. Most of them have a few apple trees though these are frequently neglected. Many farmers derive cash income from a woodlot and at least obtain fuel and building supplies for their own use. All have small flocks of hens. Almost every farmer gets some income from the sale of wheat and coarse grains. Wheat is grown in all parts of the Lowlands but it is only in the extreme southwest of Ontario that it is more important than oats. The typical grain crop is oats[12] due to their adaptability to the climate and their suitability for all classes of livestock and poultry. Barley is raised for feeding animals and for malting purposes. Small amounts of buckwheat, rye, millet, and flax are produced but the value of the oats commonly exceeds that of all other grains put together. Most of the grain, except wheat, is fed on the farm to draught animals and to beef and dairy cattle, hogs and sheep but in many years there is a surplus for sale. The farm which produces grain alone like those on the Prairies is rare. A few

[12]Derich, R. A., *Oats in Canada* (Dom. Dept. Agric., 1937); Grant, H. C *Barley Survey* (London: Empire Marketing Board, 1932).



Reproduced, by permission, from McArthur and Coke, "Types of Farming in Canada", published in Pub. 653, Dom. Dept. of Agric., 1939

farmers boast that all their grain is fed on their own farms but typically grain crops are a supplementary source of direct income. The importance of grain as a cash crop varies a good deal from one farmer to another even in the same community.

The mixed nature of the agriculture in the Lowlands can, perhaps, be brought out more clearly by means of statistics for selected sub-regions.[18] In Haldimand county, on the shores of Lake Erie about the mouth of the Grand River, the average farm is 111 acres in size of which 95 acres is cleared and the remainder is in woodland and waste. The latter consists, in this area, of sandy or gravelly beaches which were formed on the shores of the old glacial lakes but were left behind by the subsequent partial drainage of the lake. Of the cleared land about 15 acres is in oats, 7 in fall wheat, about 35 in hay crops, 15 in improved pasture, and the rest in barley, corn, garden crops, or buildings and roadways. Each farm had an average of 8 dairy cattle, 2 beef cattle and ten calves along with a few horses, hogs, sheep, and 170 hens. These figures varied considerably from one farm to another depending on the personal inclination of the farmer and the suitability of the soil, climate and location of the farm for one type of animal or crop rather than another. These figures change somewhat from year to year, depending on the existing and probable future price tendencies and the need of changing the crop rotation in order to preserve fertility, keep down weeds or attain a more complete use of labour and equipment.

The same diversity is indicated by data on the sources of farm income. On typical farms in Lanark county around Perth, Smith's Falls and Carleton Place 5 per cent of the farm income

[18]Auger, A., "Types of Farming in Quebec", *Proceedings of the Canadian Society of Agricultural Economists,* 1938, pp. 35-43; Coke, *op. cit.*, pp. 81-108; Leckie, H. K., "Farm Receipts in Three Areas in Ontario", *Economic Annalist,* vol. 10, December, 1940, pp. 94-5; McArthur, *supra*; Skinner, G., "A Soil Improvement Programme", *Agricultural and Experimental Union, Report* (Ont. Agric. Dept., 1930), pp. 45-60.

came from the sale of crops, chiefly oats, barley and potatoes, 40 per cent from livestock (hogs, cattle, sheep and poultry), 46 per cent from livestock products of which two-thirds was from milk sold mainly to cheese factories with the rest from cream and eggs. The remaining 9 per cent of the income was derived from miscellaneous sources such as the sale of timber and firewood, work outside the farm and so on. In detail there is some variation in the types of farming throughout this economic Region but the surprising matter is the broad similarity between the farms in the area, and the diversity of products raised on each individual farm. In one sub-region there may be a slightly different emphasis on one or some of the many products than in another area but rarely does one sub-region raise articles which are not produced elsewhere on most of the farms of the area. What differences exist are in relative emphasis rather than in the fundamental character of the agriculture.

One example of emphasis on one product rather than broad diversification is truck gardening. This is carried on around Montreal, Toronto, Ottawa and other large cities. Occasionally these truck farms produce vegetables and small fruits to the virtual exclusion of all other crops. In this case the farms are small—ten or twenty acres. They are farmed intensively, a large amount of labour and capital in the form of fertilizer being applied to a relatively small amount of land. Sometimes the soil is of only moderate fertility, but it pays to fertilize it well because the fresh vegetables which are raised can be sold at good prices in the nearby cities even in competition with crops from more fertile areas. The gains secured from being able to sell really fresh articles more than offset any disabilities in soil and climate, provided these disabilities are not too great. Since the highest prices for vegetables are paid for crops which come on the market in the early part of the season, great efforts are made to "force" growth. This is done by growing in hot-houses, or by beginning

growth in hot-houses and transplanting to the open field later, or by the liberal use of manure.[14] Some of these truck farms may grow small amounts of grain and hay. They may keep a horse for draught purposes or a cow or goat to provide milk for the household and use up waste products, but almost all the efforts of the farmer are centred on the growth of early vegetables and small fruits.

Truck gardens of the type just described are few in number. Typically the farms which concentrate on vegetables are still diversified. For example, around Burlington at the eastern end of Lake Ontario the average farm is 86 acres in size: there are 46 acres in field crops including 15 in hay, 10 in oats, and 14 in other cereals. In addition there are 26 acres in natural or improved pasture. The typical farm has 10 cattle (mainly dairy), 3 sheep, 6 swine and 120 hens. Yet the real hub of production is the 1.1 acres devoted to market gardens, the 1.1 acres in potatoes and the 1.7 acres in orchards. The pattern is mixed farming; the cut of the cloth is raising vegetables for sale in Toronto and Hamilton.

In certain parts of the Region, notably around Leamington and Aylmer just north of Lake Erie and in the peninsula of Prince Edward county in Lake Ontario, large amounts of vegetables are grown for canning and pickling. These districts have slightly higher temperatures and a longer growing season than some other parts of the Lowland but their chief advantage is in their soils. These are light, sandy and naturally heat up more quickly in the spring than the heavy clay of much of the Region. Moreover, the sandy soils do not form clods like clay does if cultivated when it is too wet. Hence these soils can be tilled soon after the snow melts off the fields in the spring. Crops can be planted sooner than elsewhere in the Region and can be harvested to take

[14]Boswell, V. R., and Jones, H. A., "Climate and Vegetable Crops", *U.S. Yearbook of Agriculture, 1941*, pp. 373-99.

advantage of the good market for early vegetables. Unfortunately the sandy soils are often infertile but they can be cheaply stocked with organic material supplied by animal manure or by ploughing in clover stubble.

Because of the climate and tillability of the soils, vegetables grown in the Leamington, Aylmer and Prince Edward districts are generally of high quality and excellent for canning. Then, too, these districts are rather remote from large urban centres except Windsor. Although they are trying to overcome this handicap by using motor trucks, in the main they put their vegetables into more imperishable forms before sale and send the canned or pickled products long distances, even across Canada, before sale. In years with large crops the chief problem of the farmer is obtaining enough workers to harvest the beans, peas, corn, tomatoes, cucumbers, and so on during the relatively short season when they are in prime condition for making canned vegetables, pickles, and soup.

Even in these areas specializing in growing vegetables, farming is diversified. In the Region as a whole almost every farm has a vegetable garden to meet its own requirements but what was no more than a side-line elsewhere becomes the really important business in the Leamington and other districts. Cattle, hogs, hay and grain crops are not eliminated; they merely occupy a less prominent position in the farming picture.

Sugar beets are another vegetable of importance on the general farms of a few districts in the southwestern section of Ontario.[15] In order to secure good quality and high yields per acre, sugar beets should be grown on an easily tillable soil and have plenty

[15]Brandon, E. W., and Coons, G. H., "Climatic Relations of Sugarcane and Sugar Beet", *U.S. Yearbook of Agriculture, 1941*, pp. 431-8; McArthur, I. S., "Financial Summary of Sugar Beet Farms in Southwestern Ontario", *Economic Annalist*, vol. 10, December, 1940, pp. 88-90; Stilgenbauer, F. A., "The Michigan Sugar Beet Industry", *Economic Geography*, vol. 3, December, 1927, pp. 486-507.

of sunshine, with adequate but not excessive rainfall especially in the early fall. Beets are easily frozen. Though frozen beets can be made into sugar, if thawing occurs after the initial freezing the sugar content quickly declines. Because beets are bulky as well as perishable, they must be produced near the factories which extract the sugar from them. For this reason production is confined to districts close to Chatham and Wallaceburg where the refineries are located. There is no climatic reason why beets could not be grown over a wider area but the cost of transportation is the chief handicap. A further limitation on production is the scarcity of labour willing to spend long hours at the laborious task of thinning the growing beets with a short hoe and later lifting the mature beets from the soil and removing their tops with a knife. Immigrants from Belgium and Holland usually do this work but they tend to gravitate to the cities or become general farmers and so the shortage of labour is a recurrent difficulty. Sugar beet production is carried on as part of a mixed farming regime.

The reasons for the location of fruit growing in the Lowlands show the influence of relatively minor differences in climate. The most important fruit belt is the Niagara peninsula or more properly the county of Lincoln on the Lake Ontario side of that peninsula with adjacent parts of Wentworth (surrounding Hamilton) and Welland counties. The average annual and mean summer temperatures in this district are one degree colder than at Leamington and only five degrees warmer than the average for Waterloo and Wellington counties on the escarpment in the interior of the large peninsula of Western Ontario.[16] The length of the frost-free season is about 212 days, slightly shorter than at Leamington but 23 days longer than the interior uplands. Average winter temperatures are about the same in Niagara as at Leamington but the lowest temperature experienced at any

[16]Putnam and Chapman, "The Climate of Southern Ontario", *op. cit.*

time in the former area is somewhat less severe than the minimum at Leamington. Even if they last for only a day or so, low absolute temperatures during the dormant season are detrimental to some fruits, especially to peaches. It is the greater frequency and severity of the cold spells which probably explains the concentration of the growing of tender fruits in the Niagara area even though the winter averages are practically the same as at Leamington. What is important is not the winter and summer averages but departures from the average during the dormant season. If a crop like peaches will barely mature in a certain area, slightly lower minimum temperatures may be sufficient to discourage production in one district and stimulate it in another, whereas similar differences between two areas both of which are well within the climate zone for that product will be of no great significance.

Probably the main reasons for specializing on fruit in Niagara are not climatic but economic. Fruits are grown throughout most of the Lowland Region but the yield outside of the specialized districts is often uncertain in both quality and quantity. The output is difficult to sell in competition with the superior grades of fruit from areas which are slightly more favoured climatically.[17] If the farmer is producing for his own use he may not care very much whether the quality is superior or not but the consumer in the city readily shifts his purchases to the better fruit. On the commercial market small differences in quality may have significant effects on price and the ease with which the output can be sold. Because farmers typically operate on a very small margin of profit, slightly higher prices may be a powerful influence in stimulating production in areas with rather better climate and in choking off supplies from the others. This influence may not be very potent in the case of some farm pro-

[17]Magness, J. R., and Traub, H. P., "Climatic Adaptation of Fruit and Nut Crops", *U.S. Yearbook of Agriculture, 1941*, pp. 400-20.

ducts but it is important in fruit because orchards need continuous attention if quality is to be maintained. If a farmer loses money by raising poor-quality fruit or if he gets a low yield due to frost or other damage, he may not have the funds to spray, prune and fertilize his orchard. In the following year the quality, judged by commercial standards, is still poorer than before and this in turn leads to lower selling prices and further deterioration in the orchard. The trend is likely to persist because once an orchard has begun to slip behind, it is an expensive and time-consuming task to bring it back into first-class shape.

A further handicap on fruit growing outside Niagara is the lack of skill on the part of the individual farmer. As orchards become older, fungus and other diseases grow more prevalent. Few general farmers have either the knowledge, the inclination, or the equipment to control these diseases. If fruit constitutes only an insignificant part of the farmer's total income, it will not be worth his while to acquire the knowledge, and the spraying machines, pruning hooks and so on. But on the areas with slightly better climatic conditions the farmers have already secured the skill and equipment. Also, when orchards are close together the criticism of neighbours may force all farmers to reach a certain level of performance. The spirit of emulation inspires some farmers to try to excel their neighbours. Once a farmer has committed much of his land to fruit and derives most of his income from it, he must either adopt progressive practices or go out of business. In the latter case he will lose heavily so he applies himself diligently to horticulture. A fruit-growing district sooner or later acquires a reputation for quality. It begins to attract skilled orchardists and those who have a natural bent for this type of work. Such persons feel—and properly so—that they can make more money by going to areas noted for their progressiveness in horticulture than they can in the backward

areas. Finally, the preferred area will set up its own marketing organization. This will give it a further advantage.

Concentration of commercial fruit growing in the Niagara district cannot be explained on climatic grounds alone. In fact, it is not easy to explain it on either geographic or economic factors. Probably the specialization is to be accounted for by the conjuncture of a number of superiorities. No one of these in itself is a complete explanation of the regional specialization but collectively they add up to a definite advantage over other areas.

At all events the Niagara area produces substantial proportions of the commercial crop of berries, peaches, plums, cherries, and pears, grown in the Lowland Region. It also raises almost all Canada's grapes.[18] Of course, fruits are grown widely throughout the Region although the eastern part is too cold for peaches and grapes. Most farmers have orchards to provide for their own needs and for sale in the immediate vicinity. Sometimes these local producers have advantages over their more distant and highly skilled competitors in Niagara. Strawberries and raspberries deteriorate rapidly after picking and, though they can be handled under refrigeration, this is costly. Hence "proximity to a market or some good shipping point is an important factor. Very frequently growers located near a really good market net greater returns per acre than those who, located in far better fruit areas, are either farther away from their market or are catering to a market already well supplied with fruit. . . . This closeness to an excellent market goes a long way towards making up for other deficiencies such as possible winter injury,

[18]Palmer, E. F., and Strong, W. J., *The Strawberry in Ontario* (Toronto: Ont. Agric. Dept., 1928); Palmer, E. F., and von Haarlem, J. R., *The Grape in Ontario* (Guelph: Ont. Agric. Dept., 1938); Reilly, E. E., *Farm Management—Fruit Growing in the Niagara District* (Toronto: Ont. Agric. Dept., 1920); Strong, W. J., *The Raspberry and Blackberry in Ontario* (Toronto: Ont. Agric. Dept., 1930); "Fruits in Canada", *C.S.T.A. Review*, March, 1941.

lower yields due to weather conditions, etc."[19] Nevertheless, the Niagara district supplies the larger cities like Toronto, Montreal, Hamilton, Ottawa and London with almost all their berries and tree fruits. It also provides the smaller towns and cities with fresh fruits for domestic preserving in the summer and with jam and canned goods to be sold by retail stores in these communities during the winter.

Agriculture in the Niagara district is mixed despite the emphasis on fruits. Although a few small farms raise fruits to the practical exclusion of almost everything else, the average farm is 46 acres in size, or a little more than one-third as large as the dairy farms of Haldimand county. The typical farm has 10 acres in cereals, 9 in hay, 8 in pasture and 7 in woodland. It has 4 cattle, 2 swine, and 112 hens; sheep are unusual. Yet the real heart of the economy is the 9 acres of orchards and the one acre of market gardens on each farm. On this land the farmer spends most of his time and thought and from it he derives nearly half his income. Casual talk over the fence or on the street in the nearby town on Saturday night or after church on Sunday centres around the weather and its effect on the fruit. It is the cultural atmosphere of the community, not the barren statistics which show the characteristic economic geography of a subregion. Even so, it must not be forgotten that other articles besides fruit are raised in the Niagara peninsula though all of them are subordinate economically to a product which occupies but a small percentage of the total area.

In the Niagara district careful attention has been given to the particular location of orchards. The land slopes downward from the "mountain" or escarpment to Lake Ontario in a series of benches which have been so heavily eroded over the course of time that many of them have lost their step-like character. The

[19]Davis, M. B., and Blair, D. S., *The Strawberry and its Cultivation in Canada* (Dom. Dept. Agric., 1938), p. 4.

land generally slopes toward the north. Westerly winds are more or less cut off by the escarpment and northerly winds are slightly warmed by crossing the waters of the lake.

Though the effect of the lake is to moderate the temperature, the best location for an orchard is not right on the lake shore. The water retards blossoming in the spring until all danger of killing frost is over. The water also delays frost in the fall until the fruit is mature. Both of these effects are desirable. Unfortunately, water also slows down growth during the summer. Its retarding effect then is so serious that peaches take about a week longer to ripen along the shore than they do from two to four miles inland.[20] This delay is often an important matter because the growing season is frequently none too long for peaches even on the most favourably located orchards. The moderating influence of the water favours fruit growing over the district as a whole but its effect is overdone close to the shore. Similarly, an orchard too far up the slope or too far inland may suffer from cold weather on account of its higher altitude or its remoteness from the lake. Topographic features may counter-balance the tempering influence of the water. Somewhere between the shore and the "mountain" is a place where one can obtain the advantages of the influence of the lake without its shortcomings. Another disadvantage of many lake shore locations is that strong winds blowing unimpeded across the lake may break down the limbs of trees or bruise maturing fruit.

Orchards in the Niagara peninsula, like those of the Annapolis Valley, are located to take advantage of frost drainage. Also in order to minimize the amount of "dead" or non-circulating air which is so favourable to frost and the growth of fungus, the trees are planted fairly widely apart and pruned carefully to avoid pockets of air. Because exposure to sunshine reduces fungus and heightens the colour of the fruit, the orchard site

[20]Palmer and von Haarlem, *op. cit.*, p. 15.

should face toward the sun if possible, though the existence of a slope is more significant than exposure to the direct rays of the sun.[21] Soil also influences the quality of the fruit and the type grown. Where the soil is a warm sandy loam, is well drained and well supplied with mineral nutriments the fruit matures early and has a high sugar content. Some of the minor minerals such as boron prevent dropping of fruit and its rotting at the heart while in storage. Fruits vary slightly in their soil requirements. Moist cool sands are ideal for berries but if grapes and most tree fruits are grown on such soils they often fail to mature and if they do so, their sugar content is low. Hence within this sub-region and even on individual farms there are smaller areas of specialization. Attempts are constantly being made to offset the geographic limitations of the area by developing earlier maturing varieties and by adopting cultural practices which will make for more rapid growth.

Apples grow well throughout the Niagara peninsula but only relatively small amounts are produced there. The explanation of this apparent anomaly is that the land in the peninsula can be more profitably devoted to other fruits than to apples. Grapes, peaches, and cherries are very particular in their climate requirements. There is only a limited amount of land suited to their growth and hence it must be used for them. Apples, being less exacting in their demands, are grown outside the Niagara district in areas where climates and soils, though somewhat poorer, are still satisfactory for apples. Thus it is that comparatively few apples are raised in the district most suited to their growth.

Almost every farm in the Lowlands has a few apple trees but the chief areas of commercial production are located near lake shores, particularly where rolling terrain gives good frost drainage and the soils are well drained sandy loams.[22] Commercial

[21] *Ibid.*, pp. 15-6.

[22] Coke, J., "A Preliminary Analysis of the Organization of 148 [Apple]

(Continued on next page)

production is important at several points along the sloping shores of Georgian Bay and Lake Huron, in Norfolk county north of Lake Erie, near Burlington, and east of Cobourg. The largest producing area in Quebec is around Abbotsford, in Rouville county 35 miles southeast of Montreal, due to favourable soils and terrain, good access to market, and a head start. Farming in all these apple-growing districts is diversified.

Apples produced in the Lowlands are sold mainly in the nearby cities. Very few are sent outside the Region. Most apples are sold in barrels and little attention is paid to proper display in cartons or to wrapping and polishing the fruit before sale. The varieties raised are either early-maturing or harvest apples, or types with excellent keeping qualities like Northern Spy and McIntosh. In Quebec the most prized apple is the Fameuse or Snow. Both the McIntosh and the Fameuse were developed locally and meet the climatic requirements of the Lowland Region.

In recent years tobacco has become an important crop in some districts.[28] Of course, almost from the earliest period of settlement some tobacco was grown but the "home-cured stuff" had no commercial importance. Since 1923 burley, a dark-coloured tobacco for use in cigarettes, has been grown in considerable quantities in Essex and Kent, two counties at the western end of Lake Erie and also in Rouville, L'Assomption and Montcalm counties, 35 miles southeast and 30 miles northeast of Montreal.

[28]Hudgins, Bert, "Tobacco Growing in Southwestern Ontario", *Economic Geography*, vol. 14, July, 1938, pp. 223-32; McRae, N. A., *Tobacco Growing in Canada* (Dom. Dept. Agric., 1935); Stimson, F. A. and Murwin, H. F., *Flue-Cured Tobacco Growing in Ontario* (Dom. Dept. Agric., 1941).

Farms", *Economic Annalist*, vol. 1, June, 1931, pp. 1-3; "Apple Production in the Province of Quebec", *Economic Annalist*, vol. 1, September, 1931, pp. 1-8; Gosselin, A., "Economic Aspects of Apple Production in Rouville County, Quebec", *Economic Annalist*, vol. 6, June, 1936, pp. 44-8; Horticultural Experimental Station, *The Apple in Ontario* (Ont. Agric. Dept., 1927); *Farm Management—Mixed Farming and Apple Growing* (Ont. Agric. Dept., 1920).

Light-coloured or bright tobacco for cigarette and pipe use is raised around Simcoe in Norfolk county north of Lake Erie about 75 miles west of the Niagara River.

Tobacco is a heat-loving plant which needs a growing season of from 100 to 125 days and bright warm days during that time. Nowhere in Canada is the growing season long enough so that tobacco will actually mature in the sense that it will produce seed but this is not a vital matter. We process the leaves while they are still green and so, as long as seed is imported, the plant need not complete its life cycle. The commercial tobacco districts in Ontario have some advantages of climate over other parts of the Lowlands but their main superiority is in soils, the character of which has an important effect on the quality of the tobacco raised. Generally speaking very light, easily aerated soils produce bright-coloured tobaccos while heavy soils yield dark tobaccos. The soil must be capable of being easily worked. If it lacks friability, the land cannot be prepared for tobacco early in the spring and precious days are lost getting the seedlings started. Since tobacco makes heavy demands on the soil, the ground should be rich in all the plant nutriments, especially nitrogen and potash. However, if the soils are sufficiently friable, the minerals can be added, usually in the form of artificial fertilizers because animal manures are likely to contain bacteria detrimental to the proper development of tobacco. Friability should not be secured at the expense of excessively easy drainage. If the soils are too quickly drained, the tobacco may suffer from lack of moisture and the added nutriments may be leached away before they can be effective in promoting plant growth. The ideal soil is a layer of coarse sand underlain with fine sand to hold humus and fertilizer, and supported by fine sticky sand and clay to retain water. The soils of Norfolk county approach this ideal condition. Incidentally, in the early years of settlement the lands were valuable because of their cover of pine trees

but later they were considered of no importance because they were ill-suited for growing grain and hay. With the development of tobacco growing the land has again become expensive. Physically the soils are unchanged from the days of the earliest settlers but economically they have gone through cycles of usefulness.

Growing tobacco on a commercial scale needs patience, skill and capital. This is particularly true in Canada because the growing season for tobacco is so short. A few days lost at the beginning of the season may be fatal to the production of good tobacco. Therefore the seeds are started in beds which are sterilized to destroy all soil-borne diseases. Growth is forced by raising in hot-houses, using chemical fertilizers, and even applying steam beneath the beds. The seedlings are kept in hot-houses for from four to six weeks, being "hardened off" toward the end of this period by leaving them in open air for part of the day. The seedlings are then transplanted into fields which have already been thoroughly cultivated, beginning as early in the spring as possible. Planting is usually completed by the end of May or early June. Thereafter cultivation is almost continuous in order to destroy weeds and keep the soil friable.

Great care has to be exercised during the entire period of growth. Tobacco is susceptible to a large number of pests and diseases. Cutworms, wireworms, and tobacco worms must be destroyed. Mosaic and leaf drop which is caused by nutritional deficiencies in the soil must be carefully dealt with. In late summer the top or flowering part of the plant and some of the smaller leaves are broken off in order to produce good quality in the leaves which are allowed to remain. The leaf is plucked when it becomes granular in texture and changes from a uniform green colour to light mottled green with curly edges. As the leaves do not all mature at one time, about three pickings at intervals of ten days are necessary. Sometimes, with the poorer

grades of tobacco, especially the "habitant twist" of Quebec, the entire stalk is cut down. After the leaves have slightly wilted in fields, they are very carefully carried to a drying kiln, a specially constructed barn, where they are hung up. The kiln is kept at a fairly uniform temperature throughout any twenty-four-hour period but the artificial climate must be changed from time to time to produce a high-grade leaf. The foliage must be dried evenly and neither too quickly or too slowly in order to obtain the proper texture, colour, firmness, and crispness. The entire process requires an exceptional amount of skill and care.

In addition to the flue-cured process just described, tobacco is sometimes air-cooled. It is allowed to dry for two or three months by hanging it in a well-ventilated barn under natural, not controlled, conditions. It is then kept in an air-tight box in a warm place for several more weeks and finally it is allowed to age for six months to a year. Flue-cured tobacco is sold mainly for the manufacture of cigarettes, while the air-cooled product is used chiefly in pipes and cigars.

In order to produce high-quality tobacco a good crop rotation is essential. Legumes such as clover and soy beans add nitrogen to the soil but delay maturity. Corn and timothy stimulate the root-rot disease in the tobacco. The most satisfactory crop in rotation with tobacco is rye. The market price of rye is usually low because its value as feed for livestock or poultry is mediocre. Often it is ploughed under as green manure and adds so much to the yield per acre of the succeeding crop of tobacco without transmitting disease that it is worth while to plant it in rotation. In the tobacco-growing districts wind-breaks, usually Carolina poplars, are grown to halt the chill spring winds, deflect the blowing sand which is hard on the seedlings, and provide cover for the birds which eat the insect pests.

Raising tobacco, especially under the flue-cured process, involves a heavy original investment in land, greenhouses, kilns,

and other special equipment. Operating expenses throughout the year are high and the process of production very technical. As a result some farms are owned by limited liability companies which supply the tenant with land, buildings and machinery, pay the taxes, and give expert advice. The tenant agrees to follow the methods prescribed by the company and to supply the labour. The revenue from the tobacco crop is shared on an agreed basis. The scheme of tenant-corporation farming, unique in Canada, seems to be working out satisfactorily.[24]

The St. Lawrence Lowlands is the only Region in Canada in which corn is an important crop. In the warm districts in Kent, Essex and Prince Edward counties corn will mature every year and is grown for seed. It has been found that the seed grown here is exceptionally virile and is more likely to germinate and produce good crops under Canadian conditions than imported seed. Outside of these counties the growing season is too short for corn to mature but this is immaterial, for the corn is harvested while it is still green and stored in silos to provide excellent feed for dairy cattle during the winter. When corn is raised for canning purposes the short growing season is advantageous. Canneries require corn that has sufficient "milk" to be tender and sweet, and yet enough starch to have "body".[25] Corn grown in warm climates, such as the famous Corn Belt of the United States, passes through the canning stage very quickly and soon becomes too starchy or hard. In areas farther north the corn keeps in prime canning condition longer. Thus in cool climates one is more likely to secure good corn for canning than farther south.

[24]"Corporation Farming", *Economic Annalist*, vol. 1, October, 1931, pp. 5-6.

[25]Carlson, A. S., and Weston, J., "The Sweet Corn Industry of Maine", *Economic Geography*, vol. 10, October, 1934, pp. 382-94; Jenkins, M. T., "Influence of Climate and Weather on the Growth of Corn", *U.S. Yearbook of Agriculture, 1941*, pp. 308-20; Boswell, V. R., and Jones, H. A., *op. cit.*, pp. 393-4.

Poultry are raised for eggs and meat on almost every farm in the Lowlands. Although there are a few specialized poultry farms near the large cities, for the most part the hens and chickens along with a few turkeys, geese and ducks are by-products of mixed farming. They are fed on oats, grain screenings, kitchen scraps and are allowed to forage for themselves every summer. The total value of eggs, poultry and feathers produced annually is more than one-quarter the aggregate value of milk, butter and cheese and is about four times the commercial fruit production. Canadians, whose annual per capita consumption of eggs is nearly 22 dozen, are among the world's largest consumers of this product. Until a tariff was imposed in 1930, large numbers of eggs in the shell and of egg powder for cooking were imported. In recent years the export of eggs to Britain has become important. The output of honey is considerable, especially in Ontario, which produces about 40 per cent of the total value of the Canadian crop.

Before leaving the subject of agriculture in the St. Lawrence Lowlands, it is necessary to describe the pattern of the farm lands and the system of farm tenure. In Ontario most of the farm population is of British origin either directly or through the United States. In Quebec the majority are the descendants of French who came to the colony before 1700.

Although farm buildings in Ontario are likely to be more pretentious and the village churches much less imposing than the neighbouring province, the main difference in the organization is in the shape of the farms. In Ontario the standard size is 100 acres, that is, 80 rods wide by 200 rods long. These farms are arranged in blocks one and one-quarter miles square, with main roads on either side and secondary or "side" roads separating the blocks. Usually the blocks are regularly arranged within each township but the townships vary in size and shape. The result is that while within any one township the roads are

straight and at right angles to each other, the roads in one township do not always coincide with those in adjoining townships. The regularity of the pattern even within a township is distorted by topographical features like the Great Lakes and the Niagara escarpment. The pattern is badly interrupted where settlement impinges upon the Canadian Shield because there the roads must be winding in order to avoid lakes and rocky hills and to reach the scattered patches of fertile soil. In a few of the older settlements farms were 40 by 440 rods in size and bordered upon navigable water or on trails which later became highways. On the whole, however, the farm pattern throughout agricultural Ontario is remarkably regular.

In Quebec the layout of the farms has been conditioned by the fact that settlement took place first along the rivers and each colonist insisted on access to the river, which at the time provided the only means of transportation and communication. When the original owner died, his heirs demanded the same access and since under the French civil code all the sons inherited share and share alike, the farm was split lengthwise. In this way each heir got access to the "highway" and also had a complete cross-section of the available land—level stretches near the river for crops, upland for pasture, and the most distant area for fuel and timber. When settlement had so increased that it could no longer be accommodated along the river front, a second tier of farms was opened up along a roadway or concession a mile or more behind the first. The system has the advantage[26] of facilitating the carrying on of social, religious, and educational life. Roads are easier to maintain and a given mileage of telephone and hydro-electric lines can serve more homes than in Ontario. The chief drawback is that the ribbon-like farms are sometimes so narrow that it scarcely pays to cultivate the fields at the back

[26]Barnes, C. P., "The Economics of the Long Lot Farm", *Geographical Review*, vol. 25, April, 1935, pp. 298-301.

of the farm. In extreme cases farms are 300 feet wide and two miles long but the typical farm is one-sixth of a mile in width by one mile or a mile and a half in length. The farmer tends to use only the fields at the front. Since he must secure his living from a few acres, this land is often overworked and is not as productive as it would be if proper rotations were followed and the land allowed to be in pasture from time to time. Conversely, the pasture at the back is often of poor quality, whereas if it were more accessible it could occasionally be used for crops with profit to the farmer.

In a few cases there are large estates which are subdivided into rented farms. The most important of these are owned by the Quebec Seminary, the Sisters of the Hôtel Dieu de Québec, and the Seminary of St. Sulspice in Montreal. The farm lease or métayage is based on the sharing of crops and other farm products between the landlord and the tenant. Careful regulations are made to maintain the fertility of the soil and to ensure that buildings, fences, and livestock are properly cared for.

Up to about 1900 almost all the farm land in the Lowlands was owned outright by its operators or was cultivated by tenants who expected eventually to own the land they occupied.[27] In Quebec there is a great love of the land and a strong pride in handing the ancestral acres down to the children unencumbered by debt. In consequence, over 90 per cent of the farms are owner-operated and most of the tenants are on the way "up the agricultural ladder" to farm ownership. On the other hand in Ontario the proportion of tenants has steadily increased since 1900 and is now about 25 per cent of the total. A good many

[27]Gagne, C., "Land Tenure in Quebec", *Proceedings Canadian Society of Agricultural Economists,* 1936, pp. 73-8; Coke, J., "Farm Organization", *op. cit.,* pp. 81-103; Hudson, S. C., "Trends in Land Tenure in Canada", *Economic Annalist,* vol. 7, October, 1937, pp. 74-8; Lattimer, J. E., "Land Tenure in Canada", *Proceedings International Conference Agricultural Economists,* 1937, pp. 103-11.

of these tenants never expect to own the land they till. Farms now require expensive buildings, machinery and livestock. The cost of these discourages purchase by the farm labourer or tenant to whom the road to ownership was formerly comparatively free. Besides, farm values fluctuate greatly with general agricultural prosperity whereas in pioneer days the farmer could look forward to a consistent increase in value as he cleared more of his land. Nowadays he may prefer to have someone else bear the risk of changes in land values. Thus farm tenancy is increasing in importance.

Furthermore there has been a steady increase in the size of the farm, especially in Ontario. The original homestead was commonly no more than 100 acres and often only 50 acres in size. This was large enough to give work to the farmer and his family throughout the year on account of the hand methods of agriculture then in use and the need for clearing, fencing, and draining the land. The farm gave its owner an income which, though not large, was adequate to sustain life and was at least as much as his neighbours had. Over the course of the years the land was practically all cleared and permanent buildings and fences erected. As more machinery came into use the farmer found that he could cultivate a larger area without the assistance of hired men. His family came to demand a higher standard of living. The original allotment of land became too small either to furnish full employment for the farmer and his machines or to supply the economic demands of the farmer's family. For these reasons there has been a consistent trend towards larger farms throughout the Lowlands except in the truck-gardening and fruit-growing districts. Nearly 40 per cent of all farms in Ontario are over 100 acres in size and almost every county has at least one of 640 acres (one square mile) or more. The larger farms were created by progressive farmers purchasing the lands of other farmers or their heirs who have drifted to the

city. Consolidation proceeds slowly because most farmers resist change and because it is costly to buy land on which more or less permanent buildings have been erected. Larger farms mean a relative decline in rural population and this in turn involves sociological problems of great difficulty.

Agriculture in the St. Lawrence Lowlands is, on the whole, very prosperous. This is due to the generally level topography, the comparatively high percentage of tillable land, the favourable climate, the absence of serious droughts or widespread devastating frosts, the proximity of a large market, and the skill and thriftiness of the farmers. Most of all, perhaps, prosperity is due to the diversity of products raised. Farms are mixed "in the sense that different enterprises are engaged in, but are specialized in the sense that special emphasis or major importance is attached to some one or more enterprises in the combination".

Forestry

The native forest cover of the St. Lawrence Lowland Region is mixed hardwood. The most common species are sugar maple, ash, elm, beech, basswood, and some oak along with white pine, balsam fir, cedar and a little spruce. In the southern part of the peninsula of Western Ontario and in Prince Edward county there are some additional varieties not found elsewhere in Canada such as black walnut, several types of oak, and even the red mulberry, cucumber tree and tulip tree. Toward the north of the Lowlands, particularly in the Ottawa Valley, there is an increasing representation of pine and other softwoods. All these kinds of trees are very much mixed together.

Most of the forests have long since been cut off in order to make way for agriculture but, in the aggregate, large amounts still remain, chiefly on farm woodlots. These form the cheapest and most readily accessible supplies of fuel and building materials

for the individual farmer. The woodlots need to be carefully managed if they are to continue as a valuable resource.[28]

From an industrial standpoint the hardwoods are important on account of their special qualities.[29] For example, hickory excels all other Canadian woods in strength, hardness and toughness although it is difficult to work and shrinks considerably in drying. It is used extensively for handles on tools and machines, spokes and rims of wheels, rungs of ladders and chairs. The hard or sugar maple provides a hard smooth finish with a good grain. It is used for flooring, interior finish, furniture, piano actions, shoe lasts, and butcher's blocks. Oak is a heavy tough wood which takes a smooth finish and has a lovely grain, especially when quarter-cut. Its chief markets are in furniture, flooring, interior finish, and watertight barrels. The other hardwoods, each with its own special characteristics, provide raw materials for a wide range of articles. Window sash and door frames, tubs, coffins, piano and organ frames, sleds, skis, hockey sticks, silos, refrigerators and ice boxes, apple barrels, clothes pins, skewers, and veneer are but a few of the many articles produced from the woods of the Lowlands.

A wood-using industry of growing importance is wood distillation.[30] The raw material is chiefly hardwood sawdust and waste which arises from the manufacturing and woods operations. The wood is heated and the gases given off are saved, treated, and refined to supply wood alcohol, acetate of lime, creosote, and tar. The residue is sold as charcoal. Increasing quantities of these products are used in the chemical industry, particularly

[28]Morton, B. R., *The Care of the Woodlot* (Ottawa: Forestry Branch, 1920); *Tree Repairing* (Ottawa: Forestry Branch, 1922).

[29]Lewis, R. G., and Doucet, J. A., *Wood-using Industries of Quebec* (Ottawa: Forestry Branch, 1918); Lewis, R. G., *Wood-using Industries of Ontario* (Ottawa: Forestry Branch, 1924); McElhanney, T. A., *Canadian Woods; Their Properties and Uses* (Ottawa: Forestry Branch, 1935).

[30]Bates, J. S., *Distillation of Hardwoods in Canada* (Ottawa: Forestry Branch, 1922).

in explosives and the rapidly developing field of plastics. There are other sources for all these chemicals but none so cheap as hardwood distillation.

On account of the scattered nature of the forest resources on the farm woodlots of the Region, lumbering is not mechanized. Farmers get out supplies of fuel and logs during the winter and haul the logs to a saw-mill while the snow is still on the ground. Most towns have a steam operated saw-mill and many, especially in Quebec, have a wood-working plant of some kind.

In view of the importance of hardwoods to the individual farmer, to industry and to the small towns with wood-working establishments and in view also of the declining forested area, it has been strongly urged that land, particularly land of little agricultural value, be reforested artificially.[31] Already the provinces offer free seedlings to farmers who will plant them. Ontario has also established demonstration woodlots along well-travelled highways to show the farmers how to care for a woodlot. Some municipalities have planted with trees land which has reverted to them for non-payment of taxes. No municipality in Ontario is allowed to increase the taxes on reforested land which will, eventually, have a value higher than the original cutover or abandoned farm land which has been planted with seedlings.

Despite these encouragements reforestation is proceeding very slowly. This is due partly to the inertia of the farmer but mainly it is caused by the financial risk of reforestation. Lumber takes a long time to mature—perhaps 60 to 100 years. During this time it yields no revenue beyond negligible amounts from the sale of edible nuts and the lease of hunting rights. Even cattle must not be allowed to pasture in the young forest, for they trample down the seedlings and chew off the growing shoots.

[31]Ely, R. T., and Wehrwein, G. S., *Land Economics* (New York: The Macmillan Company, 1940), pp. 271-314.

When the forest is older, cattle cannot run at large because the grass between the trees is so poor. If the trees are planted far enough apart, grass may grow but the yield of wood is less. Although almost no revenue is being received from the forest during its long period of growth, the expense of taxes, interest, and fire protection goes on steadily. When the forest finally matures, the price of lumber may be very low. Of course, if the forest resources are all being depleted and if no substitutes for lumber are found, it is reasonable to assume that the price of lumber two or three generations hence will be high but there is no certainty that it will be very much above what it is to-day. In the meantime, heavy expenses are being incurred annually. The element of risk as to whether or not these will be recovered from the selling price of lumber several decades from now disheartens investors and so reforestation on a commercial basis lags.

Although on purely business grounds reforestation may not be profitable, a strong case can be made out for it on account of its general social benefits.[82] Throughout all the Lowlands the streams are decidedly smaller and shorter than they once were. They dry up in the summer and often there is a serious shortage of water for domestic purposes and for livestock. The top-soil dries out and the winds often blow away the most valuable part of the soil. In the spring heavy floods occur, wrecking buildings and destroying farm lands along their course. Port Hope, Brantford, London, Chatham and dozens of smaller communities are almost annually subjected to loss and discomfort by the spring thaw. Water running rapidly off the land washes away soils into lakes and streams where they are useless for agriculture. It cuts deep gullies into the slopes, making part of the land

[82]Coventry, A. F., "An Ontario Experiment in the Conservation of Resources", *Industrial Canada,* vol. 40, July, 1939, pp. 131-7; "Soil and Water", in Ashley, C. A. *ed., Reconstruction in Canada* (Toronto: University of Toronto Press, 1943), pp. 44-62.

unproductive and interfering with the operation of machinery on the remainder of the field. Water is also responsible for sheet erosion by which the whole surface of the land gradually slides down a slope. Sheet erosion becomes evident when irregular light or yellow patches show up on the darker background of the surrounding earth. The yellow patches of sub-soil are relatively infertile because they lack humus which is derived from the decay of plants and their roots in the top foot or two of the soil.

The cause of all these troubles lies in the injudicious clearing of the land. Trees hold considerable quantities of water around their roots. The snow accumulates upon forested land throughout the winter and in the warm spring days it melts much more slowly than in the open. The trees also slow down the rate of flow of the water and stop its erosive tendencies even on nearby tilled fields. Forests provide recreation to the public and add beauty to the landscape. In order to provide an adequate supply of water, control floods, prevent disastrous soil erosion, and give recreation facilities, reforestation seems to be essential. It will have to be undertaken by the governments and will require the co-operation of thousands of individual landowners. Successful reforestation will preserve a resource which is valuable in itself and will prevent steadily mounting losses to agriculture.

Mining

The geological history of the St. Lawrence Lowlands did not favour the formation of minerals[38] and the mineral resources are not numerous. Buried beneath the land along the shores of Lake Huron, and the St. Clair and Detroit rivers is a huge deposit of salt—enough to supply the entire world for 2,500 years. The process of extraction is simple. Water is let down a pipe leading to the deposits. When the water has dissolved

[38]Young, G. A., *op. cit.*, pp. 79-80.

some of the salt, it is pumped up and the brine is evaporated in huge pans. In the larger plants evaporation takes place in partial vacuum because under these conditions the temperatures need not be raised as high as under normal air pressure. The salt is sold throughout all central Canada for use in homes, butter factories and bakeries, for cattle and as an essential raw material in the chemical industry.

A small reserve of petroleum exists in the Petrolia and Oil Springs area, 20 miles south of Lake Huron. Though at one time the field was very important, it now provides less than 10 per cent of the Canadian output and would keep Canada supplied with gasoline and lubricating oils for only a few hours in the year. Natural gas, obtained at several points along the north shore of Lake Erie, is used in nearby cities for domestic heating and cooking.

Gypsum is mined near Paris and at Caledonia, 20 miles southwest of Hamilton. Marble is secured near Orillia and Bancroft in Ontario and at Phillipsburg and St. Marc des Carrières in Quebec. Limestone is quarried for manufacturing cement and terazzo which is used in bathrooms and kitchens. Clay is abundant for making brick for buildings and tile for drains.

Manufacturing

The St. Lawrence Lowlands are the main manufacturing Region in Canada.[84] Before discussing the reasons for the industrial concentration, it is necessary to pay some attention to the forces which determine the location of particular industries. There are several factors involved and they are complicated in their actual operation. In fact, no completely satisfactory theory of plant location has yet been worked out.[85]

[84]Whitaker, J. R., "The St. Lawrence Lowland: the Industrial Heart of Canada", *Journal of Geography*, vol. 23, December, 1934, pp. 329-39.

[85]Haig, R. M., "Understanding the Metropolis", *Quarterly Journal of*

(Continued on next page)

Ideally all manufacturing should take place at the market for then the costs of transportation would be non-existent. In a very few cases the weight of both the raw materials and the finished product is so small that transportation can be ignored. Production therefore does take place at indeterminate points but usually at the market. Examples of such goods are artificial flowers, fountain pens, pencils, tobacco pipes, and umbrellas. Ordinarily the raw materials are found at points remote from the market. The problem then becomes one of discussing whether production will take place at the source of the raw materials, at the market, or at some place intermediate between the two.

Let us assume that both the raw materials and the finished article are imperishable and that the conversion of the raw materials into the finished goods takes place without any significant loss in weight or the acquisition of bulk. Under these circumstances it is immaterial where the plant is located. In practice the plant is likely to be near the market, since the freight rate on finished goods is commonly higher than on raw materials. The former are usually more fragile and more susceptible to loss and damage than the raw materials. Also they are able to bear a higher rate because they are more valuable.

On wheat and flour, the freight structure has, for historical reasons, been so arranged that the rate on the grain is equalized with the rate on the flour. As far as freight rates are concerned the mill may be located at any of a number of points or may be localized as a result of some other factor such as cheap power. As a matter of fact, most of the flour mills in this Region are found in the smaller towns where, before the days of cheap trans-

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Economics, vol. 39, 1926, pp. 40-79; Hartshorne, R., "Location as a Factor in Geography", *Annals, Association of American Geographers*, vol. 17, 1927, pp. 92-100; Krzyzanowski, W., "Review of the Literature of the Location of Industry", *Journal of Political Economy*, vol. 35, April, 1927, pp. 278-91.

portation, they used local raw materials and sold their product in the immediate market. Some of these mills have persisted even though they now use a good deal of hard wheat from the Prairies. Other flour mills, the larger and more modern ones, have been established in the cities because of market factors. The only other examples of industries in this category are rice, tea, coffee and spices. In these cases the raw materials are imported and the cleaning or roasting, and the packaging tends to be located at seaports such as Montreal, where the bulk is broken and the goods can be processed and shipped on with only one handling charge.

More common than the cases described above are those where raw materials and finished goods are relatively imperishable but where weight is lost during the process of production. In these instances the plant is located at the raw materials. Copper- or nickel-bearing ore plus coal produces matte, or concentrate of copper and nickel. The matte must be refined in order to separate one metal from the other and purify each one of them before sale. A much larger quantity of coal is needed for refining than for concentrating. Hence the ore is concentrated at Sudbury to reduce its bulk and weight. The matte is then shipped for refining to Port Colborne at the head of the Welland canal where coal can be brought in cheaply across Lake Erie.

An even clearer case of imperishability and weight-losing is iron and steel. To produce 100 pounds of pig iron requires about 130 pounds of coal, 180 pounds of fair-grade iron ore and roughly 25 pounds of limestone. Obviously manufacturing will take place at the raw materials since the cost of shipping the pig iron will be much less than the cost of transporting the various raw materials to market. As it happens, the three raw materials are rarely located close together. Commonly, iron ore and limestone will be brought to the coal. The reason formerly given was that the coal lost its weight entirely in the process of

manufacture, whereas the two other raw materials lost only part of their weight. It would be uneconomical to carry the coal to the ore and then haul the pig iron back to market near the coal since the combined weights of the coal plus the pig iron (230 pounds) is more than the weight of the ore (180 pounds). From this statement it was deduced that no area without a large reserve of coal could expect to manufacture iron and steel and that, conversely, the presence of coal would sooner or later lead to the establishment of a ferrous industry.

Now, as a matter of fact, iron-working industries do tend throughout the world to be located near the coal. The chief reason for this is not the relative bulkiness of the raw materials but the fact that it so happens that in moving to the coal the iron ore is also moving toward the market. This is true when the ore of Lorraine is carried to the coal of the Ruhr and the ore of Spain is transported to the coal of Britain. Similarly, Wabana ore meets Cape Breton coal and limestone at Sydney because in going to the coal, the ore is already on its way to market. Also ore from Lake Superior is carried to the coal of Pennsylvania, and the pig iron, or the steel made from it, goes on to market. If the main market for pig iron were west of the Great Lakes, the coal would be brought toward the market, meeting the iron ore on the way. In fact, this is precisely what is happening, for with the growth of automobile manufacturing at Detroit a steadily expanding iron and steel industry has been established at that point. In other words, a district may develop an iron and steel industry even though, like Detroit, it does not have a large supply of high-grade coal in the immediate vicinity. But such a district has to have enterprising business men and good workmen; it has to be a large market; and it has to possess cheap transportation so that the raw materials can be brought in from outside points.

One economic geographer has compared the relationship

between coal and industrial development with that between artificial fertilizers and vegetable life. Vegetation will not develop satisfactorily on fertilizer alone. It will thrive on naturally good soils without any fertilizer at all. For its best growth vegetation needs both soils which are naturally rich and also artificial fertilizer. In the same way coal will not guarantee industrial development to a district which does not possess the other factors needed for manufacturing. Alberta, with 85 per cent of Canada's huge coal resources, is a good example of this condition. Detroit illustrates the situation where a district without coal has become industrialized because the other elements were so favourable. Pittsburgh and other districts in Pennsylvania and Ohio show what happens when, figuratively speaking, the area has both good soils and ample fertilizer. Pittsburgh has an energetic population which got a head start over other potential iron- and steel-manufacturing centres. It has a large local reserve of coal of excellent coking quality. It has a large market in the immediate vicinity and another nearby in the industrial and shipbuilding plants along the Atlantic coast. Iron ore of high quality can be cheaply brought into the district from Lake Superior down the natural waterway of the Great Lakes. While the iron ore is moving to the coal it is also going toward the market.

The situation in the St. Lawrence Lowlands of Canada is analogous to conditions at Detroit though the market is smaller. Iron ore from Lake Superior, coal from across Lake Ontario and limestone from the nearby Niagara escarpment are brought to Hamilton, a good port at the head of Lake Ontario, for manufacture. Similarly, iron ore and coal are transported by water to meet locally produced limestone at Sault Ste. Marie and are made into pig iron and steel there. Originally ore for this mill was brought in by rail from the Helen Mine 90 miles north of the city. With the exhaustion of the high-grade ore

from this mine, ore was obtained from the ample reserves in the Mesabi Range on the American side of Lake Superior. Recently the province of Ontario has given a bounty sufficiently large to enable the Canadian deposits to be re-opened.

In recent years the production of pig iron has involved the use of substantial quantities of scrap iron. Scrap is most readily obtainable in thickly populated areas which use large amounts of iron in implements, machinery, buildings and so on. It would appear that the Hamilton mill will have an increasing advantage over its Sault Ste. Marie competitor. Since 1900 Hamilton, Sault Ste. Marie, Ojibway (near Windsor) and probably many other places have been extravagantly advertised as "another Pittsburgh". Without local resources of coking coal it is most unlikely that the Lowlands will ever have steel centres of major importance, but with a growing local market and considerable tariff protection they are likely to expand slowly.

Two other examples of imperishable articles losing weight in the process of manufacture may be given. The production of cement requires limestone and coal, of which the latter is weight-losing. Ordinarily the coal is taken to the limestone, thus accounting for the plants at Brantford, Belleville, and Beloeil near Montreal. The finished article is then sent on to market. If the limestone were taken to the coal for manufacture the bulky finished article would have to be hauled back. This would mean paying transportation charges both ways, whereas when the coal is brought to the limestone it is already on its way to market and one transportation charge is saved. Similarly, the production of brick and tile requires clay, coal and water. Clay is found at widely separated points throughout the Lowlands, water is ubiquitous, and coal must be imported. Water and coal are weight-losing. Coal is brought to the other raw materials which are already near the market. Brick and tile plants are consequently scattered throughout the Region. The

main reason why the largest plants are near the largest cities, as at Cooksville outside Toronto and St. Laurent across the river from Montreal, is that the largest markets are there.

A different situation is created when, along with conditions of imperishability, bulk or weight is acquired during the process of manufacture. The most conspicuous example of this condition is houses, though perhaps their construction does not fall under the heading of manufacturing. In any case, they must be made at the actual point of use from raw or partially processed materials brought to the market. The perfection of pre-fabricated houses will alter this condition only slightly. In the case of furniture it is much cheaper to carry the wood, cloth, padding, nails, springs and varnish to the market than it is to manufacture the furniture near the chief raw material, wood, and then haul the bulky finished product to market. This does not necessarily imply that furniture factories are always located at the large cities. Many of them are at Stratford, Guelph, Napanee and numerous other towns because many years ago some enterprising individual started them there to use the local hardwood. Once established, they trained highly skilled workers and thus have tended to remain in these towns, due to the "deposit" of skilled workers. Nevertheless, they are not far from their main markets. With the depletion of the hardwood forests and the shift to imported woods like mahogany more and more of their raw materials are brought to them and, incidentally, carried on their way to market. Other products which acquire bulk in process of manufacture are boilers, tanks and engines, barrels, and coffins. All these tend to be made in the larger cities where the chief market lies.

Another broad category of manufacturing arises when the element of perishability enters. In cases where the raw material is perishable, production takes place near the source of supply, as in fruit and vegetable canning. When the finished article

is perishable, either because it physically deteriorates like ice-cream and bakery products or becomes "stale" like newspapers, the plant is placed as near the market as possible and the raw materials brought to it. Obviously, a bakery, ice-cream plant and newspaper establishment is not located in every hamlet. The low cost of producing the articles mentioned in large plants enables them to be sold at such low prices that a small-scale works cannot compete even though it might be able to supply a really fresh article to the market in the immediate vicinity. For this reason commercial bakeries have displaced the house-wife who formerly baked the bread and pastry for her family. For the same reason the plants in the smaller towns are finding it increasingly difficult to carry on in the face of severe competition from city establishments delivering perishable articles by fast truck in the surrounding territory. Though plants making perishable finished articles are located near the market, changes in the economic conditions of manufacturing and transportation are constantly altering the definition of the word market.

In a few cases both the raw material and the finished product are perishable. Live cattle, a perishable raw material, lose weight in transit because they are without adequate feed, water, or room for exercise for several hours and they mill around in the freight car, injuring each other. Before the days of refrigeration the finished product, meat, was even more perishable than the raw material and so there was no alternative but to ship the cattle long distances from the point of production to the market for slaughter. Since the development of refrigerated cars and storage warehouses, it is more profitable to slaughter or "manufacture" the cattle near the source of supply, for in this way transportation is saved on the inedible parts of the animal amounting to about half the live weight. The meat can now be carried in better condition than the livestock. Technological advances have reversed the localization of the industry.

The statement that packing houses tend to be located near the raw materials does not mean that every cattle raiser or even every town and city has one. There are very considerable economic advantages in having a large-scale plant. Highly skilled labour may be employed, specialized machines can be purchased and kept in operation all the time. In the small plant such machines would be idle so much of the time while their interest and depreciation charges continued that it would not be profitable to have them. By-products thrown away in the small plant because of insufficient volume to use them effectively, can be utilized in the large plant. Research can be undertaken. In selling, the large plant has the advantage that its salesmen can handle a number of different products with the same total expense for salaries and travelling and thus the selling expense to be borne by any one of the products is reduced. The economic advantages of having a plant near the place of production of the raw materials must be set off against the gains of large-scale production.

Occasionally the elements of perishability and weight-losing or weight-gaining are combined. In making cheese, condensed milk, and wine, the raw material is made less perishable and at the same time is concentrated in volume. Manufacture of these articles takes place near the raw material. On the other hand, the baking of bread involves taking imperishable raw materials and putting them in a more perishable and bulky form. Therefore baking is done mainly at the market. A special category of perishability arises where the process of manufacture itself is dangerous and the materials and finished product rather less so. Explosives, widely used in Canada even in peacetime due to their importance in mining and construction, are made in isolated communities usually on the edge of the Shield.

The localization of all industries, however, cannot be explained by the two factors of perishability and loss and acquisition

of weight and bulk. Sometimes labour is a controlling factor. Ample supplies of immigrant labour willing to work for low wages in their own homes or in poorly lighted and ventilated factories tended to establish the manufacture of suits, dresses, children's clothing, overalls and uniforms in Montreal. Although sweat shop conditions are being eliminated, the industry tends to persist in this centre because of its head start. An additional advantage is that the industry can use the labour of young women from the large French-Canadian families. This was one of the factors leading to the establishment of the rayon mills at Cornwall, Ontario, close to the Quebec boundary. Another aspect of the labour situation is that some industries tend to be located where skilled labour is already available or where there are good technical schools to train them. They prefer a place where there is a "deposit" of skill, an asset of value just like a metallic deposit.

Still another localizing factor is power. This is important in the St. Lawrence Lowland in spite of the fact that the Region has no resources of coal and almost none of petroleum. However, it can obtain coal relatively cheaply from Pennsylvania across Lakes Erie and Ontario, or by rail. Coal is also brought in up the St. Lawrence River as far as Montreal from Nova Scotia and Britain. The chief energy resource is hydro-electricity which is delevoped at Niagara Falls and in the rivers which flow down along the edge of the Canadian Shield. Cheap energy has led to the establishment of electro-chemical and electro-metallurgical industries such as carborundum at Niagara Falls, Ontario. Equally important, though less spectacular, is the low cost of power to a wide variety of industries throughout the Lowlands.

Some industries are located in this Region because of a head start. When farm implements and tools were made entirely or largely of wood, it was natural that their production should be

concentrated in the Lowlands where hardwoods such as oak and maple were available. Indeed, such a location was inevitable because at this time there was almost no agricultural development west of the Great Lakes. Yet even when iron and steel implements were used, even when the West was opened up and its agriculture had become highly mechanized, there was no shift in implement manufacture. It persisted in the Lowlands despite their lack of local supplies of coal and iron and the fact that implements acquire bulk in the process of manufacture. The fundamental reason for the failure to transfer the industry to the West is a head start. Moreover, the Lowlands can probably bring in coal and iron more readily than the Prairies can import iron ore or pig iron and manufacture implements with their own low-grade coal. The increase in the bulk of the finished article above the bulk of the raw materials from which it is made can be partially offset by shipping the implements "knocked down" and assembling them near the market on the Prairies. It must not be forgotten either that farmers in Ontario and Quebec use considerable machinery. The diversity of the agriculture in the Lowlands provides the manufacturer with a market for a wide variety of implements. This market among mixed farmers gives the implement business greater stability than it would have if it were dependent mainly on the market among Prairie wheat farmers. Finally, the Ontario implement manufacturer is well located with reference to the export market which normally absorbs about one-third of the total Canadian output. In short, the Lowlands had the benefit of a head start but this has been supplemented by other advantages of considerable importance.

The manufacture of transportation equipment illustrates the importance of another factor in the localization of particular industries. Almost all the automobiles, automobile supplies, and bicycles are made in Ontario. This is chiefly due to the comparative ease of assembling the numerous parts which go into

these products. An automobile is a collection of parts made from steel, copper, brass, rubber, cotton, glass, paint, and plastics. Only an area with a widely diversified manufacturing life of its own or one which is able to draw readily on such a region (the northern United States) can economically establish such an industry. Although the finished product is bulky, it can be shipped knocked down and the final assembling operations conducted elsewhere. The Lowlands have advantages in being able to ship by water to the Maritimes, British Columbia, and the important export market.

Limitations of space have permitted a discussion of only a few of the major industries of the Lowlands. In addition to the ones mentioned there are many more plants manufacturing all sorts of articles from wire fence to magazines, from cigarettes to jute bags. The effect of locating numerous industries both large and small in this Region is to create an industrial segment in the Canadian economy.

The mere fact that this Region is already highly industrialized attracts new industries. By establishing here, manufacturers can draw on existing supplies of skilled labour. They can collect semi-processed goods from other factories in the vicinity. They are able to raise capital easily because they have better contact with savers and financial institutions than more remote producers. In particular they can borrow manufacturing and selling techniques from the nearby, highly industrialized sections of the United States. This borrowing is common in the case of the numerous branches of American firms which have been set up in Canada in order to take advantage of the preferential rates of duty which various parts of the British Commonwealth give to each other. Of course, plants located anywhere in the Empire would receive about the same preferences as those in Canada but control by the parent American concern is easier when the branches are relatively near at hand which means, in most cases,

in the Lowlands. Borrowing of techniques is not confined to branch plants of American businesses for concerns wholly owned by Canadians also absorb ideas from their neighbours across the line.

Industry in the Lowlands gains from its location toward the geographic centre of Canada. This advantage is strengthened by the existence of cheap water transportation down the St. Lawrence to the Maritimes and the export market and up the Great Lakes to the Prairies. For many years the Canadian Shield was a barrier to communication with the West. Even after railways were constructed, they ran for hundreds of miles through unproductive territory. In fact, these lines were often appropriately called "bridges" because they joined productive territory at either end but yielded no more business along their actual routes than does a bridge across a river. Recently the lines of communication across Northern Ontario have lost their bridge-like character. This has been due to the development of mining and forestry in the Shield. The growing demand for industrial and consumers' goods in the Shield has helped manufacturing and trade in the Lowlands and has given a large amount of new and profitable business to the railways. Moreover, the connections between manufacturers and merchants in the Lowlands and on the Prairies are not as attenuated as they once were because this gap in the internal trade of Canada has been more or less filled in.

At all events the Lowlands have a large market close at hand. About 60 per cent of the population of Canada lives in the two provinces of Ontario and Quebec. The great majority of these people are in the Lowlands themselves, not in the parts of the Shield and the Appalachian Regions which are politically incorporated in the two provinces. About one-eighth of the Canadian population lives in the peninsula of Western Ontario, nearly one-twelfth in Greater Toronto and one-tenth on the

island of Montreal. The population of the Lowlands is divided linguistically and racially but this is not a serious matter from a purely business standpoint.

The creation of this industrial segment was undoubtedly aided by a head start over the rest of Canada except the Maritimes. The latter Region, however, suffers from so many geographic disabilities that, unlike the Lowlands, it has not been able to maintain its lead. The fact is that the Lowlands have very considerable natural resources of value to a widely diversified manufacturing. Although the Region lacks coal of its own, it can import this essential raw material relatively cheaply from adjacent parts of the United States or from the Maritimes. Also its shortage of power has been offset by ample supplies of cheap hydro-electricity. It has easy access to such raw materials as asbestos, copper, nickel, a little iron, hard and softwood forests (for furniture, newsprint and rayon) and grains, dairy products and livestock. Industry seems to be tending away from heavy iron and steel toward alloys, luxuries and plastics which require less heat in their manufacture than the older types of manufactured goods. This Region may be expected to improve its relative position as a result of shifts in industrial methods.

The net effect of all the advantages, both geographic and economic, is the concentration of about 60 per cent of all Canada's manufacturing in the Lowlands and 80 per cent in Ontario and Quebec including the parts of the Shield which are contained in these two provinces. There is nothing in the present industrial picture to indicate any significant shift of industry away from this area.

Hydro-Electric Power

The economics of hydro-electric power will be examined in connection with the Shield where the Dominion's largest resources lie. At this point it is sufficient merely to point out that the Low-

lands can readily draw upon the output of adjacent parts of the Shield and in addition have large resources of their own.[36] The Niagara River between Lakes Erie and Ontario falls a distance of 326 feet of which roughly half is concentrated at the Falls themselves. The river flows in large and steady volume, the maximum discharge being 224,000 and the minimum 158,000 cubic feet per second. The relative regularity of the flow is due to the comparatively even distribution of precipitation throughout the year. Also the forests which cover large parts of the basin drained by the lakes and rivers above Niagara hold water about their roots, allowing it to escape gradually, thus equalizing the flow. Finally, the Great Lakes act as natural reservoirs storing water in seasons of heavy rainfall and permitting it to flow off at other times of year. The flow along the Niagara is being increased by diverting streams north of Lake Superior into the St. Lawrence system from their normal outlet into Hudson Bay. On the other hand, the generation of additional power along the Niagara is limited by the necessity of preserving the beauty of the Falls.

The total amount of energy at present being developed from the Niagara River is normally about 525,000 horse-power for use on the Ontario side of the International Boundary, with an equal amount on the American side. The Canadian generating plant is located at Queenston below the Falls where, by drawing water through canals and penstocks from above the Falls, it makes use of the drop of the water in the rapids below the Falls as well as the sheer drop itself. Besides regularity of flow of water, the Niagara plant has the advantage of being located on a plain which has a favourable climate and fertile soil and is the centre of a populous agricultural, trading and industrial

[36]Ontario, *The Hydro-Electric Power Commission of Ontario; its Origin, Administration and Achievements* (Toronto: 1928); Brouillette, B., "Combustibles et Force Motrice", in Minville, *op. cit.*, pp. 240-70.

district. In addition to the Niagara plant, the Lowlands have easy access to the hydro-electric power potentialities of the Shield and the Appalachian highlands. As the Gatineau, Ottawa, St. Maurice, Saguenay, Lièvre and other streams flow in large and regular volume from these rocky uplands onto the plain, they are harnessed and power developed.

Many of the present generating plants are capable of extension and new projects can be developed. The largest single potential source of power is along the St. Lawrence river between Kingston at the foot of Lake Ontario and Montreal. Along this distance of 185 miles the river drops a total of 226 feet chiefly concentrated in three or four small sections. Some of these sites are already being used on a limited scale. Further exploitation is restricted by the necessity of getting concurrent legislation by the Dominion of Canada, the provinces of Ontario and Quebec, the United States Congress, and the state of New York. In addition, there are difficulties of raising the necessary funds and of finding a market for the four million horse-power which will be rather suddenly thrown on the market because hydro-electric plants cannot usually be completed in piece-meal fashion but must be constructed almost to their ultimate capacity at one time.

From the various developments already in operation in the Lowlands and adjacent parts of the Shield large amounts of power are available for use in homes, retail and wholesale establishments, for street lighting, and on farms. Large blocks of cheap energy have led to the establishment of electro-chemical and electro-metallurgical industries such as those producing carborundum at Niagara Falls and aluminum at Kingston. Equally important, though less spectacular, is the use of electrical power by a wide variety of industries throughout the Lowlands.

In Ontario practically all the power is generated and distributed by a provincially owned system under the control of the Hydro-Electric Power Commission in co-operation with muni-

cipally owned utilities in the various cities, towns, villages, and rural districts. The Commission generates power and distributes it to the various municipalities who buy it in large blocks and "retail" it to domestic and industrial consumers. Public ownership has been highly successful because of the efficient management and freedom from the more injurious types of political influence. The Commission can borrow money cheaply because interest and principal on the bonds are guaranteed by the province. The system was started at an opportune time when the demand for power was increasing rapidly and the problems of the economical generation and transmission of hydro-electric power had already been fairly well solved by private companies. The Lowlands have no resources of coal and almost no petroleum. Hence competition between hydro-electricity and other forms of energy is not as acute here as in regions which possess their own supplies of high-grade coal and oil.

In Quebec the water-power resources have been developed by private capitalists but the provincial government has built or acquired storage reservoirs to even out the flow of water in the St. Maurice and other rivers. The cost of repairing the dams and of paying the interest and amortization charges on them is borne by the hydro-electric companies which have benefited from their construction. Until 1944 the Quebec government merely regulated the rates, capitalization, and services of the private concerns but recently it has embarked on a policy of public ownership and operation by expropriating the company which supplies hydro-electricity to Montreal. In both provinces the rates for power and light are low, chiefly due to geographic advantages. Especially favourable rates are given to industries which will undertake to use power when it is not required by householders, street railway systems and other consumers who cannot conveniently postpone their demands.

Fishing

The fisheries of the St. Lawrence Lowlands are of minor importance in comparison with those of the Atlantic and Pacific coasts but they do provide fresh fish to nearby communities and give a livelihood to small numbers of men. Salmon, once so plentiful in Lake Ontario that they were hauled away by the wagon-load for fertilizer, have entirely disappeared due to the drying up of streams. Sturgeon are almost gone and whitefish are badly depleted. The most common species now being caught are pickerel, pike and bass. There are frequent complaints that the entire fisheries resource is disappearing and continued demands for enlarging the fish hatcheries. On the other hand, one authority[37] states that the propagation of fish in hatcheries, though practised since 1868, has had hardly any effect on the stock of fish as far as the Great Lakes are concerned. In 1872 the Minister of Marine and Fisheries first complained of fish de-population in Lake Ontario but in all but five of the years since that time the catch has exceeded the *largest* yield up to then. Fluctuations in fish population seem to be caused chiefly by natural factors rather than by depletion by commercial fishermen. Further knowledge of the natural causes will alleviate unreasonable fears of the industry disappearing. Fishing in the lakes and rivers of the adjacent parts of the Shield is an important tourist attraction for centres along the northern edge of the Lowlands.

Recreation

The tourist industry is significant in the Lowlands despite their lack of spectacular works of nature except Niagara Falls. The Region benefits from its proximity to New York, Buffalo, Detroit, and in fact to the most thickly populated parts of the United States. It provides, north of Lake Erie, the shortest route connecting Detroit and the large cities in Michigan, with

[37]Huntsman, *op. cit.*

Buffalo and the urban centres in New York state. Thus there is a large "transit traffic" by rail and automobile. The Region has catered to the tourist traffic by constructing highways which are the best in Canada and by erecting hotels and camps at summer and winter resorts. In Quebec the provincial government has "schools of tourism" where it trains men and women interested in the tourist business.

Although Niagara Falls is the only natural phenomenon of world-wide note in this Region, hundreds of quiet rural scenes are not without beauty. The lakes along the edges of the Canadian Shield as in Muskoka and the Rideau and Kawartha chains attract fishermen, canoeists, and summer cottagers generally. The same thing is true of the Canadian Shield north of Ottawa and Montreal. The Great Lakes, especially the lower parts of Lake Huron and Georgian Bay, the northern shore of Lake Erie and the eastern end of Lake Ontario, are lined with the summer homes of people from Ontario and United States cities. The more open spaces, the less congested roads, and the somewhat cooler climate than in the United States attract visitors who may stop over-night, or for a day, or a month. Winter sports, like skiing, are important, particularly in the Montreal and Ottawa areas. The Dionne quintuplets have attracted thousands of visitors to Ontario.

In Quebec the chief attractions are the historic associations of Quebec city, Montreal and other places, and the positive charm of a rural life which has only recently begun to feel the impact of western industrialism. The invitation of the provincial government to tourists to "see Europe without leaving North America" is a statement of fact.

The tourist business provides a good part of the livelihood of guides, hotel-keepers, restauranteurs, service station proprietors, and the vendors and manufacturers of souvenirs, diamonds, furs, chinaware, woollen goods and other articles which Americans can buy more cheaply in Canada than they can at home. The tourist

trade also supplies an outlet for Canadian food products. From an economic standpoint the supply of goods and services to American tourists travelling in Canada is equivalent to the export of goods and services of the same value to the United States. The only difference is that Americans are being served on one side of the border rather than the other.

General

The St. Lawrence Lowlands are the real heart of Canada. They contain the bulk of the population, have the most prosperous and diversified agriculture, and are the centre of the largest and most highly developed industries. It is natural, therefore, that the Lowlands should also be the banking and commercial nucleus of the Dominion. This superior position is based on climate, soils, hydro-electric power, cheap transportation along the St. Lawrence and the Great Lakes, and many other factors already mentioned in connection with particular economic activities. An important source of strength is access to the manufactured goods and manufacturing methods of the most industrialized section of the United States which lies immediately south of the border. In fact, the Lowlands are economically part of the manufacturing district of the northeast quadrant of the United States. This district is rivalled only by northwestern Europe as a centre of industrial activity. At the same time the Lowlands in their French-speaking sector are the nucleus of loyalty to Canada as the ultimate object of political allegiance. In their English-speaking section the Lowlands are the core of loyalty to the British Empire as an object of respect, almost above the political interests of Canada herself. From an economic standpoint the Lowlands are a single unit. This unit is divided racially, linguistically, and religiously. It has many economic affinities with the industrial life in the neighbouring parts of the United States but, though their reasons are different, each of its two sections is determined to maintain the political independence of Canada.

CHAPTER IV

PRAIRIE REGION

THE PRAIRIE REGION of Canada is the northern part of the broad zone of plains and plateaus that extend from the Gulf of Mexico to the Arctic Ocean. The Canadian section occupies the wide area between the Canadian Shield to the east and north, the Rocky Mountains to the west, and the International Boundary to the south. At the forty-ninth parallel the Region is approximately 800 miles wide but the westward trend of the Shield narrows this to about 400 miles in the vicinity of Peace River and to less than 100 miles at the mouth of the Mackenzie.

Physiographically almost the entire Mackenzie Valley is a plain broadly similar in surface features to the valley of the Saskatchewan and its tributaries farther south but from the standpoint of climate, native plant life and human use of resources, the two valleys are quite different. Hence it is necessary to depart from the strict physiographic divisions. The Mackenzie River Valley, not including the valley of the Peace, will be dealt with in another chapter along with the Hudson Bay Lowlands. In this chapter the Prairie Region will include the southern section of the Plains, drained by the Peace, the upper Athabaska, the Saskatchewan and its tributaries, and the Red and Assiniboine rivers.

Topography

In a broad sense the Prairies are one physiographic Region but they can be divided into three subsections, each with a different

elevation above sea level and with slightly different landscapes.[1] Broadly speaking, the first section is the province of Manitoba south and west of the Shield. The boundary between the Shield and the Plains runs roughly along a line from the southeastern corner of Manitoba to the northwestern corner of Saskatchewan through Lakes Winnipeg and Athabaska. Along this boundary, the Plains merge into the Shield without significant change in elevation but with a marked difference in topography and soil. The smoothly rolling plains and fertile soils give place to the rounded hills and the rocks of the Shield. The western boundary of the first steppe is located roughly along the border between Manitoba and Saskatchewan. It is marked by a sharply defined escarpment rising, over a breadth of several miles, to heights of 400 to 1,000 feet above the Manitoba Lowland. The escarpment is broken by wide valleys except in the Pembina, Riding and Duck "mountains". The average level of the first steppe is about 800 feet above the sea. The steppe is remarkably uniform in topography because it was once the bottom of glacial Lake Agassiz of which Lake Winnipeg is the modern remnant.

The second prairie steppe lacks the clearly defined boundary lines of the first. In general it extends from the Saskatchewan-Manitoba boundary to Wood Mountains and the Cypress Hills near the International Boundary and thence northwestward to cross the North Saskatchewan River in the vicinity of North Battleford. The average elevation of this steppe is about 1,600 feet above sea level. This Saskatchewan steppe is not so level as Manitoba, being diversified by low hills and ridges. In fact the surface, except locally, is not a true plain but is rolling and is traversed by valleys many of which, even the wider, are trench-like in form.

[1]Atwood, *op. cit.*, pp. 251-78; *Natural Resources of the Prairie Provinces* (Ottawa: Dept. of Interior, 1925); Kitto, F. H., *Manitoba, Canada; its Resources and Development* (Ottawa: Dept. of Interior, 1931).

The third steppe lies between the second escarpment and the Rocky Mountains. This steppe rises gradually from the poorly marked escarpment along its eastern boundary to elevations of between 4,000 and 5,000 feet above sea level along the flanks of the mountains on the west. The major waterways, rising in the Rocky Mountains and flowing eastwards, have cut rather deep broad valleys into the gently upfolded flanking strata. The valleys divide the stratified rocks bordering the Rockies into sections so that they appear as detached ranges of hills. Thus between the plains proper and the main mountain range of the Cordillera system, there intervenes a narrow belt of high broken ridges known as foothills. In the vicinity of the Milk River in southern Alberta and Saskatchewan a small area has been heavily dissected by streams and partly covered with iceborne material. The corresponding section in Montana is known as the Missouri Coteau. The Cypress hills are sandy, rolling, and were originally clothed with jack-pine locally known as cypress. Due to the absence of proper drainage and the low rainfall in some of these southern districts, saline lakes and alkali flats are common.

Geology

The plains and plateaus of the Prairie Region have been sculptured from great thicknesses of sedimentary strata.[2] These strata were formed from detritus washed down from the Canadian Shield on the east or from the land which was once uplifted in the interior of British Columbia before the Rockies came into being. Sandstones and shales were laid down in the shallow waters of the broad trough which stretched from the Gulf of Mexico to the Arctic Ocean. These were altered by later crustal movements but in the main have not been greatly disturbed.

During the great Laramide Revolution which marked the end

[2]Young, *op. cit.*, pp. 128-41.

of the Mesozoic and the beginning of Cenozoic time, the Rocky Mountains proper were uplifted. As the mountains were upraised, the strata on their flanks were turned upward too, sometimes nearly vertically. But the greater part of the strata in the broad trough west of the Shield was undisturbed structurally though it was elevated more or less uniformly with reference to the sea. The salt waters which had occupied this region fairly regularly for millions of years permanently withdrew. As the lands rose above the sea there began a period of erosion which has, generally speaking, continued until the present. During this long interval the surface has been gradually but unevenly lowered. In places the younger rocks have been completely removed though occasionally they remained in plateaus.

During the Pleistocene period of Cenozoic time, the Prairie Region was invaded by a continental glacier. The centre of the chief ice-sheet affecting the Region was in Keewatin district of the Northwest Territories, on the opposite side of Hudson Bay from the Ungava sheet which operated in eastern Canada. The Keewatin sheet spread slowly southward nearly 1,500 miles to Kansas and westward nearly 1,000 miles to the edge of the Rockies, where it met tongues of glacial ice moving out from the mountains. The effect of the ice-sheet on the present topography of the Prairies lay not so much in eroding the surface of the strata as in carrying boulders and finer detritus from the Canadian Shield and depositing these upon the underlying, nearly horizontal strata to the west. During the advance and retreat of the glacier the pre-existing drainage channels leading toward the north and east were blocked by ice. As the ice melted, waters became blocked between the front of the ice and the height of land between the present Nelson-Saskatchewan and Missouri-Mississippi drainage basins. The most important of the glacial lakes formed in this manner was Agassiz which occupied the whole of the present Manitoba Lowland and which at

one time drained into the Mississippi. At some time or other the entire Plains Region was probably under a glacial lake of varying depth and unstable shore-lines. At all events, glacial moraine along with detritus re-worked by the water in glacial lakes forms a nearly continuous cover over the Prairie Region. The thickness of the cover varies from a few feet to several hundred. Everywhere the glacial detritus hides the bed-rock except in the escarpments and along the beds of large rivers.

The geological history of the Region is such that high mineralization is not likely. The only minerals of importance are those associated with stratified rock like coal, natural gas, petroleum, gypsum, salt, and clay for brick and pottery. Of these, the coal is potentially the most valuable but since it has never been subjected to tremendous pressure, it is of mediocre to poor quality. On the other hand, the geological development has helped create conditions favourable to agriculture.

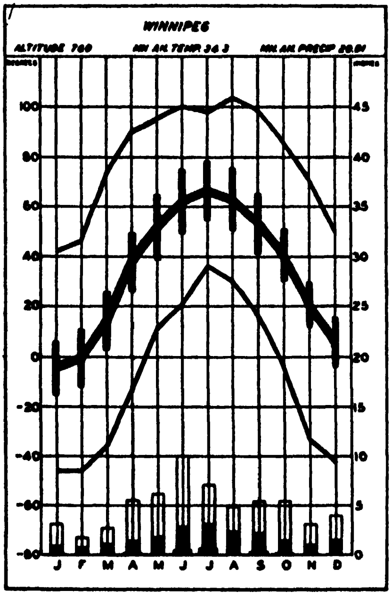
Climate

The conflict of polar air masses and the presence of cyclonic storms affect the climate of all Canada[3] but their influence is seen most clearly on the western plains.[4] As already pointed out, Prairie winters may be exceptionally mild (10 to 25 degrees Fahrenheit above the long-run average of 8 degrees above zero

[3]Connor, A. J., *The Climate of Manitoba* (Winnipeg: Manitoba Economic Survey Board, 1938); Hurd, W. B., and Grindley, T. W., *Agriculture, Climate and Population of the Prairie Provinces of Canada* (Ottawa: Dominion Bureau of Statistics, 1931), pp. 9-21; Murchie, R. W., and Grant, H. C., *Unused Lands of Manitoba* (Winnipeg: Man. Agric. Dept., 1926).

[4]Alty, S. W., "The Influence of Climate and other Geographic Factors upon the Growth and Distribution of Population in Saskatchewan", *Geography*, vol. 24, March, 1939, pp. 10-33; Mackintosh, W. A., *Prairie Provinces; The Geographic Setting* (Toronto: The Macmillan Company of Canada Limited, 1934), pp. 1-185; National Resources Committee, *Regional Planning; The Northern Great Plains* (Washington, 1939); Thornthwaite, C. W., "Climate and Settlement in the Great Plains", *Yearbook, op. cit.*, pp. 177-87; Trewartha, G. T., "Climate and Settlement in Subhumid Lands", *ibid.*, pp. 167-76.

at Winnipeg) or they may be extraordinarily cold (10 to 20 degrees lower than normal). Every winter the cold weather comes in waves or "spells" in which for a few days during the anticyclone the temperature may drop to 40 below zero and occasionally in the north to 60 or 70 below. A cold spell accompanied by strong winds and snow is called a blizzard.



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Following the cold "snap" the temperature will moderate to above zero—on relatively mild days to as much as 30 degrees above. In unusually cold or "arctic" winters cold waves follow each other in quick succession and there is little relief from the persistently low temperatures. Winter—the period during which

the average temperatures are below freezing—is about five months long, from November to March inclusive.

Precipitation is always low during the winter. The polar air mass dominating the Region for most of the time is cold to begin with and blows over frozen, snow-covered surfaces. Its moisture content is low because air at low temperatures will hold no more than a small amount of water vapour. Also air drops its moisture only when its temperature falls so that it becomes super-saturated with water vapour. Air which is already very cold is not likely to cool much further and even if it did, precipitation from it would be light.

Spring, which is arbitrarily taken to be the first day with a mean maximum temperature of 43 degrees Fahrenheit, begins in southern Alberta during the last week of March and advances quickly toward the north and more slowly along the forty-ninth parallel. Spring temperatures are reached by April 14 throughout the settled part of the west. The weather during April and May is subject to great variations from day to day and from one year to another. Belated cold waves and killing frosts sometimes occur, while in other years temperatures may reach 80 or even 90 degrees.

Summer can be considered as beginning when mean daily temperatures reach 70 degrees. This figure was selected by Hurd and Grindley because wheat is planted without certainty of maturing in the area beyond the line where the temperature equals or exceeds 70 degrees during the month of July. "It seems, therefore, that although the criterion of a mean daily maximum of 70 degrees or higher is a very arbitrary measure of the duration of summer, it has considerable merit as applied to the Canadian West". On this basis summer begins on May 20 and ends on September 12 at Medicine Hat. It lasts from June 12 to August 20 at Edmonton, and from June 25 to August 17 at Grande Prairie. Occasional hot days may be experienced during the

summer, temperatures of 100 degrees being not at all uncommon from Medicine Hat eastward along the International Boundary. The autumn is a period of variable weather with occasional cold days and light snow. It is usually of varying length because the winters may set in early or late depending on the relative strengths of the conflicting polar and warm air masses.

The Prairies are a Region of low precipitation. The average is about 15 inches annually. In southeastern Alberta and southwestern Saskatchewan the average is even less—only 10 or 12 inches annually but it increases to about 20 inches in the Red River Valley and in the northern settled areas. Rain falls whenever vapour-bearing air masses ascend, expand, and cool to such a temperature that they are no longer able to contain their moisture. In the Prairies rains of short duration and local importance may occur along the squall line of the cyclonic storm. Sometimes, too, winds pick up moisture from the surface of the earth in the immediate neighbourhood, rise, expand, cool, and drop their moisture in local thunderstorms but in order to have steady rains over a broad district in the West, southern air masses must come in contact with the relatively cool air of polar origin during a cyclonic "storm". Moist air must rise continuously up the slope along the warm front above the masses of cold air.

Unfortunately the environmental conditions which give rise to widespread rains are relatively uncommon throughout the West. The Region is cut off from the moist winds from the Pacific by the Cordillera which is both high and broad. The polar air masses contain almost no moisture though they are important in providing a suitable environment so that the warm southerly air masses may give up the water vapour which they possess. Most of the precipitation is brought in by cyclonic storms from the Gulf of Mexico and the southern part of the North Atlantic. Because the Prairies are so far removed from the source of moisture, precipitation is low. Often in summer humidity is high,

indicating the presence of water vapour, but no rain falls due to the absence of cold air to condense the vapour. The breaking of such a drought may be accompanied by heavy rains but these may come too late in the season to be of any value to crops. During this dry spell warm air may flow into southern Alberta from the plateaus to the south. The combination of strong sunshine and great heat during these rainless spells rapidly depletes soil moisture and may seriously reduce crop yields. Thus there is always a good deal of variation in precipitation from one year to another. Thornthwaite recapitulates Prairie climate by saying that "the Great Plains, so situated as to be inundated successively by moist and dry, by cold and hot air masses, suffer from meteorological excesses and in consequence experience large fluctuations in climate".

The effect of this climate on present-day agriculture and soils can be realized clearly if one considers the native flora of the Region.[5] In the Manitoba steppe before the days of settlement trees, principally poplar and Manitoba maple, grew only in narrow fringes along the rivers. Away from the borders of the streams the ground was covered with an abundance of relatively long grass—3 or 4 inches—as well as asters, goldenrod, and other flowers. In the Saskatchewan and Alberta steppes the native vegetation was divided into three belts stretching east and west. In Palliser's Triangle the grasses, chiefly gramma and buffalo grass growing in clumps, were very short. Palliser's Triangle, really a rough pentagon, extends along the forty-ninth from longitude 100 to 114 degrees, with its apex continuing for some distance along the fifty-second parallel. In places, especially in the Milk River Valley, there are large sandy tracts covered with short grass interspersed with low cactus. Northward of Palliser's Triangle is a district, the Central Plains, where the

[5]Klough, A. B., and McDougall, E. G., "The Faunal Areas of Canada", *Handbook of Canada* (Toronto: The University of Toronto Press, 1924), pp. 195-206; Lloyd, F. E., "The Vegetation of Canada", *ibid.*, pp. 218-21

grasses increase in length and trees grow along the edges of the rivers in "bluffs" as they are locally known. Still farther north is the Park Belt where trees grow in light stands over a good deal of the area but spaced between them are "prairies" or treeless fields a few hundred acres in size, with rather long native grass. The Park Belt occupies a broad crescent with a depth of roughly 100 miles below the northern limit of railways. Beyond the railways (except the Hudson Bay and Waterways lines) trees cover almost all the area as they do in adjacent parts of the Shield.

The reason for the treeless character of most of the Prairies is a matter of dispute.[6] The common explanation is that the rainfall, though ample for grass, is insufficient for arboreal growth. A heavy cover of grass tends, in a district of light rainfall, to absorb substantially all the moisture so that none remains for the deeper roots of trees. Also a thick covering of grass forms a solid mat into which the seeds from trees find it hard to penetrate. Buffalo and, later, cattle ate off or trampled down the young seedlings. Finally, fires in the grass would be likely to destroy the incipient trees whereas the grass, having greater powers of recovery, would soon begin its life cycle again. Fires might be started by natives either accidentally or with the object of forcing a heavier grass cover in the following year or driving back the trees so that a larger area would be available for buffalo. In any event, it has been observed that after white men came and wherever fire was prevented from starting and spreading, the bluffs increased in size. In the words of a Canadian poet, "the trees marched across the plain".

The nature of the soils reflects both the geological history and the climate of the various sub-regions. Generally speaking, the underlying shales and sandstones have weathered down to fertile

[6]Newbigin, M. I., *Plant and Animal Geography* (London: Methuen & Co. Ltd., 1936), pp. 137-41.

clays and clay-loams. As the Pleistocene glacier retreated behind the height of land which divides the waters that flow by way of the Mississippi and its tributaries into the Gulf of Mexico from those which run into Hudson Bay and the Arctic Ocean, lakes were formed along the front of the glacier. Into these lakes silt was carried by streams flowing from the surrounding land or from beneath the glacier. With the disappearance of the glacier and the clearing away of obstructions in the natural drainage outlets to the north the lake was emptied. The silt which had previously been deposited in the lake bottom was exposed at the surface. This soil is very fertile because it is composed of material which has been ground mechanically by ice from native rock. As soon as the soil was exposed at the surface of the earth, leaching by precipitation began, but since the rainfall is light and the soils are of very recent origin, geologically speaking, the soils have been able to retain their pristine fertility to an unusual extent. Throughout the Region the original physical basis of the soil has been modified by the cover of vegetation. Where the native grass cover was light, the soils are light brown in colour due to the limited amount of humus or decaying vegetable matter left in the soil. As the vegetation increased in thickness, the soils become darker, varying gradually from chestnut brown just north of Palliser's Triangle to the dark brown soils of the Park Belt and the black soil of the Red River Valley in Manitoba.

In the last few years a good deal of attention has been given in the three Prairie provinces to an accurate survey of the soils.[7] In previous decades governments permitted settlement to take place wherever farmers were willing to buy land. Many of the

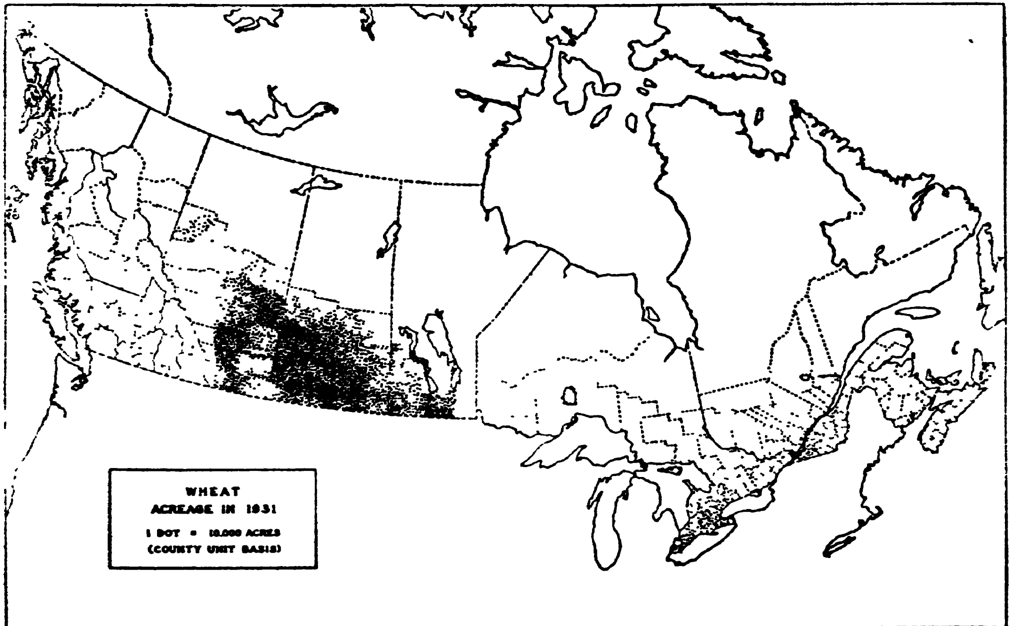
[7]Allen, W., "Land Utilization Policy with particular reference to Western Canada", *Proceedings of Canadian Society of Agricultural Economists*, 1935, pp. 23-35; Craig, G. H., "Objectives in the Alberta Land Utilization Survey", *Economic Annalist*, vol. 6, pp. 70-1; Hurd and Grindley, *op. cit.*, pp. 22-4; Johnson, S. E., "Land Use Readjustments in the Northern Great Plains", *Journal of Land and Public Utility Economics*, vol. 13, May, 1937, pp. 153-62: Mackintosh, *op. cit.*, Appendix, pp. 205-34.

incoming settlers were incapable of intelligently judging the quality of the soil or were misled regarding the climate by the accident of a few years of good rainfall. Accordingly, much land was settled which could not be profitably farmed in the long run. Sooner or later the farmers had to abandon this land. The result of errors in choosing land for settlement was financial loss to the individual as well as to governments which had to give relief and bear the cost of rehabilitating the farmers elsewhere. These expenses could have been avoided if the nature of the climate over a long cycle of years had been more clearly understood. Unfortunately climatic records over a long period were not available. But the soil is a faithful historian of climate. A study by competent agronomists of the texture of the soil, its humus content, its chemical constituents, and their arrangements in layers or horizons will reveal rainfall conditions over the past centuries. Wherever soil studies show marked deficiencies or great variability of rainfall, cereal crops will be unprofitable. Obviously, soil surveys at present being undertaken in the West cannot prevent past mistakes in settlement. Yet they can be used to determine proper future settlement policies and are helpful in finding the best methods of rehabilitating lands previously settled but now abandoned.

Agriculture

The most important occupation in the Prairie Region is farming and the typical agricultural product is wheat.[8] Normally in Saskatchewan wheat occupies about two-thirds of the total area annually seeded to field crops. It provides about 80 per cent of the cash receipts from farming over the province as a whole

[8]Lattimer, J. E., "Wheat in Canadian Agriculture", *Scientific Agriculture*, vol. 18, February, 1938, pp. 289-99; MacGibbon, D. A., *The Canadian Grain Trade* (Toronto: The Macmillan Company of Canada Limited, 1932); Swanson, W. W., and Armstrong, P. C., *Wheat* (Toronto: The Macmillan Company of Canada Limited, 1930).



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and on the Central Plains nearly 100 per cent. In its native habitat wheat was a drought-tolerant grass. Despite its acceptance of low moisture, wheat could not subsist on the limited rainfall of the Canadian Prairies were it not for the fact that precipitation comes mainly during the growing season. For its best development wheat needs adequate moisture in the spring so as to get well started and then some rainfall later in the summer when the kernels begin to fill out. Less than average rainfall in the spring cuts down yield per acre. Shortages in the summer also lower yield since the kernels do not become plump but this is partly compensated for by an improvement in quality, because lower than average summer rainfall usually means a better than average amount of gluten. Too much rainfall is detrimental because it stimulates the growth of stalk at the expense of the grain itself, promotes the development of parasites (rust), and lowers the gluten content.

Experience has shown that the amount of precipitation during the winter is of much less significance than the amount during and immediately after seeding and during the filling out period. When the snow which has fallen in the winter melts in the spring, it usually runs quickly off the frozen surface of the ground and is not available for plant growth. Occasionally snow falls in the autumn before the ground has frozen deeply and solidly. The snow acts as a blanket or insulator during the winter, preventing the soil from freezing to any considerable depth and in the spring the melted snow may sink into the ground. Generally speaking, the light snows are an advantage to the West because they permit the air and the top-soil to heat up more quickly in the spring than if a large part of the sun's heat was consumed in melting a thick blanket of snow. The climate of the Prairies is far from perfect for wheat growing as our study of the variability of yields per acre from year to year will show but the climate is, nevertheless, more suited to wheat than to any other product.

The soils, too, favour wheat growing. For the most part they contain ample nutritive elements, are easy to till, and are free from stones. They have a relatively high content of nitrogen, a food which high-grade hard wheat requires, but the chief cause of the superior quality of Western Canadian wheat is the relatively hot, dry weather during the period of seed development. The topography of the Region also assists in wheat growing because the level land allows machinery to be used extensively.

To some extent the Region is handicapped by being situated in the heart of the continent. It is separated from Liverpool, the main grain market of the world, by a long and expensive journey by land through Eastern Canada or the United States and thence by water. This disadvantage is counter-balanced by the presence of the Great Lakes and the St. Lawrence River which provide a navigable waterway for part of the year to within about 400 miles of the eastern edge of the grain-growing area. The shortness of the distance across the North Atlantic is of value and the water route through Vancouver and the Panama Canal is of growing importance. The main offset to the interior location of the area is the speed and economy with which grain is handled. The facilities for storing grain in elevators and for moving it in trains and ships operate at a very high state of efficiency. Even so the cost of carrying and insuring a bushel of grain from the time it enters the country elevator until it is sold in Liverpool averages 35 cents. Were it not for the exceptionally low freight rates given by Canadian railways on grain and for the efficiency of operation of the grain business generally, Canadian grain growers would find it hard to compete with the Argentine, India and Australia where there is only a short haul by land and then a long, but cheap, haul by water.

On the whole, Canada is a low-cost producer of wheat on account of advantages of climate, soil, and topography and organization—and in spite of her location. The fact that wheat

is a relatively imperishable product is of doubtful value. It enables the Canadian farmer to sell in a distant market without incurring costs of refrigeration and preserving. On the other hand, wheat can be stored comparatively cheaply and the carry-over from a year of high crops to succeeding seasons tends to keep down prices in other years.

In comparison with Eastern Canadian wheat the Prairie product is hard and vitreous. It has a high gluten content due chiefly to the relatively dry and hot climate. Prairie wheat has excellent bread-making characteristics. In North America bread is made from hard wheat alone but in Europe hard Canadian wheat is mixed with the softer European product. This gives a lower quality loaf than that to which the North American is accustomed, though it is better than bread made from soft wheat alone. Prairie wheat is planted in the spring and harvested in the late summer—chiefly in the early part of September. Eastern Canadian wheat is planted in the autumn and begins its growth then, lies dormant during the winter and then revives in the spring to produce a crop of relatively soft wheat for pastry by the middle of July. Winter wheat cannot be grown on the Prairies because there is no thick mantle of snow to protect the sprouted grain during the severe winter and because the cold weather sets in with a sudden heavy frost which breaks up the ground, exposing the wheat. Wheat sown in the autumn on the Prairies is winter-killed.[9] Besides hard wheat, the West raises some durum, used chiefly for macaroni and spaghetti. Because of its greater resistance to stem rust, durum has been displacing hard wheat in some districts but the introduction of rust-resistant varieties of hard wheat may be expected to reverse this trend.

[9]The precise cause of winter-killing is not yet determined. See Salmon, S. C., "Climate and Small Grains", *U.S. Yearbook of Agriculture, 1941*, pp. 321-42.

Wheat is produced in the West by mechanical means. This has always been true but the development of improved machines in the last few years has put wheat production on even more of a factory basis. In 1910 the average number of bushels of wheat grown per person engaged in agriculture in the West was 780 but by 1930 this had increased to 1,388. At the same time more of the agricultural worker's time was devoted to coarse grains and dairying in the latter years than in the former. In 1910 the ground was prepared by ploughs and discs drawn by horses or, occasionally, by steam tractors. The seed was planted by the same power. The ripened grain was cut by binders drawn in sets or series by horses. It was stooked by hand and later drawn by team and wagon to be threshed by machinery. The amount of land which a farmer could look after during seedtime was much more than the amount he could handle in harvest. Large numbers of men were brought in every fall to stook and thresh the grain. By 1929 mechanization had proceeded so far that the "harvesters excursions" from Eastern Canada were discontinued.

The new machines, the introduction of which accounted for the great increase in production per man and in the decline in the need for seasonal help, were the gasoline or coal oil (kerosene) tractor and the combine.[10] In general, tractors are cheaper than horses except when the price of fodder is very low. Although the annual charges for interest, depreciation and repairs are

[10]Allen, W., "Farm Organization in Western Canada", in Booth, *ed.*, *op. cit.*, pp. 104-27; Booth, J. F., "The Western Farmer's Interest in Prices", *Economic Annalist,* vol. 1, February, 1931, pp. 5-6; "Some Economic effects of Mechanization in Western Production", *Proceedings Canadian Society of Agricultural Economists,* 1933, pp. 4-20; Grest, E. G., "Cost of Tractor Operation on Prairie Farms", *Economic Annalist,* vol. 3, July, 1933, pp. 83-5; Hardy, E. J., "Combine Harvester in Western Canada", *Scientific Agriculture,* vol. 12, November, 1931, pp. 121-9; Hopkins, E. S., Armstrong, J. M., and Mitchell, A. D., *Cost of Producing Farm Crops in the Prairie Provinces,* Dom. Dept. Agric., 1932; Stewart, A., "The Economics of

(Continued on next page)

high, tractors need not be fed during the winter when little power is required, and they can be worked for longer periods than horses in the spring and early fall when the rush of work is great. The cost of using tractors is greatly influenced by the number of hours worked. Unless more than 500 hours work is done in the course of a year, it is not profitable to operate a tractor instead of horses because the interest and other charges are spread over too small an output of work. The minimum-sized farm for the economical use of a tractor is from one-half to three-quarters of a section (320 to 480 acres), depending on whether or not part of the work is done by horses. A further difficulty with tractors is that the size of a plough or seed-drill suited for horses is too small for the tractor to use advantageously. Either the small equipment is used ineffectively or the farmer is put to the expense of purchasing larger auxiliary implements. The introduction of the tractor is not the simple physical problem of substituting a mechanical for an animal source of power but the economic problem of securing a suitable-sized farm and re-adjusting the entire machinery to the new technique.

The combine is a machine for cutting off the heads of grain standing in the field and threshing them at once. By saving the expense of cutting, binding and stooking the grain and then hauling it to the separator to be threshed, the combine has been instrumental in reducing costs. Grain which is binder cut will mature a little in the stook but combine-cut grain must be fully mature on the stalk, otherwise the grain which is threshed a little on the green side will become tough. Sometimes if grain is allowed to stand on the stalk until all of it has become thor-

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Machine Production in Agriculture", *Essays in Canadian Economic Problems* (Montreal: The Royal Bank of Canada, 1931); Stewart, A., "Changes in Methods of Agricultural Production in the Prairie Provinces", in Booth, *ed., op. cit.*, pp. 128-42; Stutt, R. A., "Changes in Farm Organization and Economy in Southwestern Saskatchewan", *Economic Annalist*, vol. 10, October, 1940, pp. 71-7.

oughly ripe, it may be threshed out or shattered in the field by the wind blowing the over-ripe ears against each other. On other occasions the grain is blown down (lodged) by the wind or falls as a result of the work of the saw-fly. In these cases the combine may not be able to pick up and thresh all the heads. Green weeds in the crop are detrimental to combining because the surrounding grain absorbs moisture from them. Grain in the hollows ripens more slowly than that on the knolls. Finally, the grain absorbs moisture during the night and can be harvested by combine during only part of the day. Also, if rains occur during the harvest season the combine cannot be used satisfactorily.

In brief, the combine is most suitable where the grain is free from weeds, ripens uniformly, will not shatter while standing, and where there is no rain in the harvest period. The conditions necessary to combine operation are more likely to be found in southern Saskatchewan than in northern Saskatchewan or Alberta or in Manitoba. As in the case of the tractor, the most economically-sized farm for the combine is somewhat larger than that needed for the binder, at least 500 acres being the minimum for profitable operation.

The use of the tractor and the combine have been instrumental in enabling the wheat grower to produce grain at lower and lower costs. This development helped the farmers in the West to go through the period of exceptionally low wheat prices from 1928 to 1940 with less personal hardship than they would otherwise have suffered. This was a great advantage. Steadily improving agricultural techniques have enabled the Prairies to offset their geographic handicaps of low rainfall, a short growing season, and comparatively high cost of transporting their goods to the world market. On the other hand, the lower costs in Canada have intensified competition in grain markets abroad. Britain, France, Italy and other importers of grain raised their

tariffs to give protection to their own high-cost producers. In the United States the farm *bloc* used the low cost of production in Canada as an argument for raising their tariff against a possible inflow of Canadian grain.

Even within Canada the increasing mechanization of agriculture has raised problems. The new machines require larger farms. Since the arable land in the vicinity of present settlements has already been occupied, larger farms involve the displacement of some farmers. This raises the problem of providing alternative employment for the farmers who are pushed off the land by technological advance. Because farm machinery is likely to be steadily improved, it may be that in future years farms, like modern factories, will have to be entirely re-equipped from time to time with the latest mechanical contrivances. Most significant of all, highly mechanized agriculture has increased the dependence of farmers on the relationship between costs and prices. In areas where a farmer produces primarily for his own use as in Central Europe, or where he raises a considerable proportion of his own requirements as in Eastern Canada, he is able to survive a period of low prices. But on the Prairies the farmer has always produced fundamentally for sale and has bought all the things which he needed from local retailers or mail order house. He is a commercial farmer rather than a subsistence one. Should prices fall greatly or markets be cut off by tariff action the western farmer is squeezed between a drastically reduced income and relatively rigid cash expenses for repairs to machinery, tractor fuel, interest, taxes, and living costs.

In short, the Prairie farmer is vulnerable to fluctuations in the world prices for grain. This has always been true but the situation was aggravated by the continued shift to machinery which used fuel produced off the farm and involved large annual provision for interest, repairs and depreciation. The heavy dependence on one crop and the steadily increasing use of machinery has

entangled Western agriculture in a nexus of cost and selling prices. This is ideal when world trade is free and the price level good but it becomes disastrous in the lean years of depressions.

The extreme variability of net income in the Prairie region was impressed upon the Canadian people in the 1930's.[11] It is axiomatic in climatology that the lower the average annual rainfall the greater its variability from year to year. Western Canada is no exception. This is an important matter, for "in the wheat belt of Canada agriculture is carried on close to the minimum conditions required for its success. Over the greater part of the region where it is necessary to conserve moisture the margin of safety is comparatively narrow". If precipitation declines to only a little below the average, yields will fall off greatly because the average is barely high enough to carry on agriculture profitably. It has been estimated that each inch of precipitation between 6 and 18 inches in any given year represents an increase in the yield of about 2.5 bushels per acre. It has been calculated, too, that over the Region as a whole about 12 inches precipitation is the minimum necessary to cover expenses. It is very important that the farmer receive more than this minimum because most of his expenses are on an acreage basis. An increase in yield due to higher rainfall means greater revenue with very little additional expense. Farmers make money only when the rainfall is higher than average or when a short crop sells at a high

[11]Bladen, V. W., *Introduction to Political Economy* (Toronto: University of Toronto Press, 1941), pp. 96-144; Britnell, G. E., *The Wheat Economy* (Toronto: University of Toronto Press, 1939); Britnell, G. E., "Saskatchewan, 1930-35", *C.J.E.P.S.*, vol. 3, February, 1936, pp. 508-29; Elliott, G. C., "A Study of Wheat Yields in South Central Saskatchewan", *Economic Annalist*, vol. 8, June, 1938, pp. 35-40; Mackintosh, *op. cit.*, pp. 172-85; Stewart, A., "An Economic Survey of the Drought Area", *Economic Annalist*, vol. 7, June, 1937, pp. 39-43; Waines, W. J., "Problems of the Drought Area in Western Canada", in Innis, H. A., *Essays in Political Economy* (Toronto: University of Toronto Press, 1938), pp. 205-18; Watson, W. N., "A Study of 126 Abandoned Farms in the Lomond Area of Southern Alberta", *Economic Annalist*, vol. 6, June, 1936, pp. 205-18.

price per bushel in the world market. Since Western grain growing is on a commercial basis, the farmer watches the weather and world prices with anxious eyes.

The total precipitation in Saskatchewan averages about 10 or 12 inches in Palliser's Triangle and from 14 to 19 in the Park Belt. The critical period for rainfall as far as wheat growing is concerned is the amount which falls during the growing period. Fortunately, the proportion of the annual precipitation which falls at the critical time tends to increase as the annual rainfall decreases. This factor serves to compensate for the lower annual precipitation in the south but the evaporation is greater there, due to the slightly higher temperatures and especially to the hot winds which occasionally blow in across the International Boundary. As one goes farther north the moisture problem becomes less acute but frost is more probable. The frost-free season, the average number of days between the date of the last killing frost (29 degrees Fahrenheit) in the spring and the first killing frost in the fall, is as long as 140 days in part of the Red River Valley of Manitoba but shortens to about 105 to 110 days toward the north of the present settled area. These are average figures, however, and since the farmer can never be sure of the average, he must adjust his agricultural practices to the minimum growing season, which is a few days shorter than the average.

The northeastward slope of the land gives relatively lower altitudes to the northern sections than to the south and theoretically should give higher temperatures and a longer effective growing season. Also, due to the longer periods of daylight, the amount of sunlight received during the growing season increases toward the north. Probably both the slope of the land and more hours of daylight are very much overrated factors in favour of the north.

The net result of all these factors which affect the regularity of crop yields from one part of the Prairies to another, is that

Palliser's Triangle is characterized by greater variability than the northern parts of the present cereal-growing area. In the period 1921-36 there were crop failures (less than five bushels per acre) in more than half the years in some districts of the south but in only two years in most of the north. In short, climatic factors make the entire wheat-growing area one of uncertain yields but the uncertainty is greater in the south than in the north. Because agriculture is being carried on close to the minimum conditions for growth, crop failures are frequent.

This condition is made more serious by the fact that agriculture in this Region is on a commercial not a sustenance basis as in parts of European Russia where somewhat similar climatic conditions are present. A relatively self-sufficient farmer would have vegetables and other field crops to fall back on, but the farmer who grows only wheat and who grows it for sale in distant markets is impoverished if the wheat crop fails or if prices fall. Both disasters occurred in the 1930's. Many farmers had no crops at all even for years on end, especially in the south. Farmers in the Park Belt experienced reduced yields but suffered even more from the drastic and world-wide drop in agricultural prices which occurred at this time. It was indeed the coincidence of drought and low prices which caused widespread loss and forced the Dominion government to extend relief on a large scale. It is conceivable that both these calamities may not occur at the same time in the future but there is no assurance they will not. At any rate, uncertainty in yield is inherent in the wheat-growing Region for it is a direct result of basic climatic conditions.

In view of the serious situation in the 1930's and the prospects for similar if not equally disastrous conditions in the future, a good deal of effort has already been made and many plans have been proposed for guarding against similar difficulties in the future. One of these proposals has been to encourage diversi-

fication on the farms. The early farmers in this Region grew only wheat and purchased all their other food from nearby stores. A few of the newcomers tried gardens but since almost all their attention was given to grain growing, the gardens were neglected.[12] Gradually the idea became prevalent that it was impossible to grow vegetables on the Prairies. This misconception has taken many years to break down. At present most farms raise some lettuce, radishes, carrots, turnips and potatoes but the quality is often mediocre and the total quantity is not large. In the neighbourhood of the large cities, particularly on the dark soils near Winnipeg, truck gardening is significant but throughout most of the Region vegetables are of minor importance.

Growing vegetables in the West necessitates more care than in Eastern Canada. They must be protected from the drying winds of summer by a wind-break of boards, sunflowers, trees and shrubs. The wind-break may also have the effect of delaying the melting of the snow in the spring and thus adding to the moisture content of the soil. Suitable cultivation practices, especially summer fallowing, are of great value and irrigation is useful wherever water is available. The breeding of drought-tolerant varieties of vegetables also holds possibilities. Unfortunately, plant breeding is a slow process and cannot create plants with new characteristics. It can merely accentuate characters already present. The growing of fruit is beset by even more difficulties than vegetables but the prospects are by no means as hopeless as the early settlers supposed. Although locally-grown fruit and vegetables would be of some assistance in helping the farmer to "get by" in a poor year and raise his standard of living in good years, they are obviously not adequate answers to the problem of highly variable yields in the basic crop.

[12]Leslie, W. R. and Godfrey, W., *Vegetables for Prairie Farms* (Dom. Dept. Agric., 1939).

A more widely discussed proposal for avoiding the risks of a one-crop agriculture in the Prairies is the development of dairying.[18] To the extent that dairying could be undertaken the West would gain very greatly. Dairying would create a greater stability in farm income. It would distribute the farmer's labour more evenly throughout the year and give him some income, even though it might be a small one, at times when grain growing does not require his attention. Dairying would tend to prevent impoverishment of the soil because it would supply animal manure and give a better crop rotation. It would make it easier to control weeds, because barley and oats mature more quickly than wheat, thus allowing the farmer to harvest the commercial crop before the weeds have gone to seed. The most important of these advantages is the greater regularity in income.

In view of these advantages some people used to think that a widespread crop failure would not be an unmitigated disaster to the West because it would compel that Region to broaden out its agricultural production. In the 1930's drought on a scale undreamed of and accompanied by low prices for wheat existed for almost an entire decade. Yet, although there has been some change, the Prairie farmer has not swung to dairying to the extent believed possible and desirable. In part this is due to more or less temporary factors. In years of low income farmers have neither the money nor the credit to buy a herd of cows and re-equip their farms with large barns and cream separators. Also, farmers here lack experience in dairying and object to a type of agriculture which cannot be carried on almost entirely

[18] "Canadian Hog and Bacon Industry", *C.S.T.A. Review*, vol. 8, May, 1936, pp, 421-526; Craig, G. H., Proskie, J., and Wood, V. A., "The Production of Fluid Milk in the Edmonton and Calgary Milk Sheds", *Scientific Agriculture*, vol. 27, March, 1937, pp. 401-19; De Long, G. E., *The Production of Cheaper and Better Forage Crops for Livestock* (Dom. Dept. Agric., 1931); Hopkins, E. S., "Major Problems in Field Husbandry", *Scientific Agriculture*, vol. 17, August, 1937, pp. 754-60; Hurd and Grindley, *op. cit.*, pp. 49-56.

by machinery. Their wives refuse to be tied down to milking cows every night and morning without fail.

These difficulties would doubtless be overcome in time but the basic trouble is geographic. Nature has not provided large sections of the West with enough rainfall to support a prosperous dairy industry. It is hard to obtain good summer pasture. Originally the Region was grass-covered and native hay still grows in a few unsown meadows and on the wet ground around sloughs. Its quality is poor for dairy cattle though satisfactory for beef. In any event, the hay is nearly gone because the land can be more profitably used for other types of crops.

Cultivated grasses such as hay, clover, and timothy will grow well in wet years but it is hard to get them properly started, that is, get a good "catch", in seasons with average or less than average rainfall. Alfalfa has proved satisfactory because it supplies a large tonnage of healthful, appetizing feed per acre. Its long roots draw water from deep in the earth but, naturally, it cannot obtain water if nature has not already provided it. Once a good catch of alfalfa is obtained the farmer is likely to keep on using it for pasture as long as it produces any fodder at all. Thus alfalfa is not handled to as good advantage as it would be if it were in a proper crop rotation programme. Western rye grass has a dependable growth in all but the driest seasons. Because it is dry and wiry, it is not palatable for most stock unless used in moderate quantities and mixed with other feeds. Crested wheat grass is the most promising of all the forage crops with which experiments are now being carried on. The difficulty of securing adequate quantities of succulent summer pasture still imposes a handicap on dairying in the Prairies.

Even more intractable is the problem of supplying feed during the long winter. Ensilage, the usual feed for winter milk production in Eastern Canada, is not easily supplied in the West. Except in parts of the Red River Valley in Manitoba, corn will

not grow well due to its susceptibility to frost damage. Sunflowers can be depended upon to produce a crop every year and give high yields per acre. Unfortunately, they are not particularly nutritious or palatable. Like corn, they do not recover once they are touched by frost. In any case the work of ensiling either corn or sunflowers conflicts in time with harvesting and threshing grain. Silos, never numerous, appear to be decreasing in numbers in recent years.

Perhaps the most important supply of winter fodder is secured from "oats green-feed". Oats are planted very thickly in fields so as to get a finer stemmed crop that is more palatable than oat straw grown from thinner seedings. These oats are cut when they approach maturity, while the grain is in the firm dough stage. If cut later the oat grain is plump and dry but the oat stalk is dry and unpalatable. Oats cut at the green-feed stage are harvested and fed like any hay crop. Experiments are continually being carried on to obtain a cheap crop which will supply nutritious, palatable feed for dairy cattle throughout the long winter. So far, these experiments have been only moderately successful.

The limitations on dairying which have just been described are most acute in the south where the rainfall is less and the evaporation greater than in the north. The blunt fact is that geographic factors have forced the light brown soils within Palliser's Triangle to be primarily a beef cattle region and dairying on an extensive scale is virtually impossible. Farther north in the Central Plains, where the native grass was a little longer and the soils chestnut brown in colour, dairying is a little more practicable. Even so, this area is geographically suited to wheat and to wheat alone. Many farmers have as much as 90 per cent of their crop land in wheat. In concentrating on grain they show a keen practical understanding of the principles of economic geography.

Only in the Park Belt are climatic conditions reasonably well suited to dairying. Precipitation is higher and evaporation is less on account of the lower average temperatures. Drying winds are less common than farther south. Forage crops grow more readily and there is usually an adequate supply of drinking water for milch cows. Nevertheless, in 1931 in none of the census divisions (roughly corresponding to large counties in Eastern Canada) did the value of livestock and livestock products exceed one-third of the total farm income. The Park Belt is still predominantly grain with some livestock, whereas the Triangle is a grazing country and the intermediate zone with chestnut-coloured soils is almost solely a grain producer.

Despite great theoretical advantages, dairying is of secondary importance to the West as a whole. The Prairie provinces have ceased to be importers of butter and cheese which was the case in Manitoba, the longest settled district, until as late as 1915. In fact, the Prairies now send out dairy products to Eastern Canada and British Columbia, even though the transportation costs on the relatively perishable products are high and there is keen competition with goods raised locally in these more humid regions. During the second World War there has been a pronounced shift to dairying due partly to motives of patriotism and the desire to produce the articles which Britain urgently required, and partly because the government subsidized dairy products while discouraging wheat production. When these incentives are removed, farmers may quickly revert to grain growing which gives quick but uncertain returns with a smaller investment.

Dairying will doubtless continue to hold a small yet important place in Western agriculture especially in the Park Belt, but the main reliance will undoubtedly be on wheat. The adamant facts of climate have determined in advance that this is primarily a cereal-growing Region. This situation might be changed if

forage crops better suited to a Region with low rainfall were developed. It might be altered too if the prices of livestock and of dairy products were to rise considerably and the net returns from this type of agriculture remain persistently above the income to be derived from growing wheat. But unless the price relationships of the future are drastically different from what they are at the present time, the Prairies will continue to be a wheat-producing Region for the reason that wheat is the product which is best adapted to its climate, soils, and topography.

If this argument is sound, the most profitable line of approach to the economic problem of the West lies in improving its capabilities as a grain producer and mitigating, if possible, the variability of its income. This can be done either by the development of varieties of wheat which are more tolerant of drought, or by adopting better practices of cultivating the soil, or both. Only in this way can the West meet the competition of other cereal-producing areas.

Plant breeding[14] has already accomplished wonders for the agriculture of the West. Marquis wheat, developed in the early twentieth century by Sir Charles Saunders, matures in a little over one hundred days. Its creation was possibly the most important single factor in leading to the great development of grain growing in the West and certainly was responsible for extending the grain belt northward to its present limits. Garnet and Reward, though less successful than Marquis, have also been important. As time has gone on, a better knowledge of the principles of plant breeding has been secured and the new types should be more readily developed in future than in the past.

[14]Barnes, S., "Economic Aspects of Drought Resistance", *Scientific Agriculture*, vol. 12, December, 1931; pp. 206-8; Harrington, J. B., "Cereal Crop Improvement for Dry Farming Conditions", *Scientific Agriculture*, vol. 16, November, 1935, pp. 113-20; Newman, L. H., "New Wheat Creations and their Significance to Canada", *Canadian Geographical Journal*, vol. 18, April, 1939, pp. 208-16; *The Best Varieties of Grain* (Dom. Dept. Agric., 1940).

On the other hand, it must be realized that good wheat must possess a number of characteristics besides drought tolerance. It must have a high yield per acre, be able to mature quickly, have good baking properties, not shatter in the wind, and ripen uniformly so that it can be harvested by combine, and it should produce good-quality straw. Harrington emphasizes that "it is possible to originate varieties which are more drought resistant than those now used but great care must be taken to insure that the attainment of high drought resistance is not achieved at a sacrifice of the other characters equally valuable . . . Since the size of the crop in any particular district in Western Canada has practically no relationship to the market price of wheat, a variety which will produce 10 bushels per acre in a poor year and 40 bushels in a good year is more valuable than one which will produce 11 bushels per acre in a dry year and 30 bushels in a favourable season. The plant breeder must keep this point constantly in mind as there is a great temptation during a series of dry years to pay too much attention to differences in yield. . . . If an agricultural area were consistently so dry that only the most drought-resistant varieties could be grown, one would have to grow them. But when an area has large variations in annual precipitation with a series of favourable and unfavourable years, it is not obvious that it should use the most drought resistant. In fact, it is the favourable years that make it possible to carry on through the unfavourable ones. Consequently the behaviour of crops during the favourable years is a vital matter". It may be noted that we have been breeding wheat for half a century and have produced only four or five varieties of commercial value. Of these only Marquis has been pre-eminently successful. The problem of breeding a drought-tolerant grain is by no means as simple as appears on the surface.

Stem rust[15] is another problem faced by grain growers in the Prairies. Stem rust is a fungus, or small parasitic plant which lives off other growing plants. It attacks the stem and sometimes the leaves of all types of grain. Its virility varies from year to year depending on weather conditions. In general, weather which is best suited to the growth of crops is ideal for rust. Besides cutting down the yield per acre, rust reduces the grade of the crop which is produced, for it creates shrivelled, light-weight kernels. The average annual reduction in yield from rust on wheat, oats, barley and rye in the Prairies during the period 1925-35 has been officially estimated at 35 million bushels or about 11 per cent of the potential yield. The total loss, including the lowering in quality, was close to $40,000,000 per annum.

To prevent these losses several lines of attack are possible. During the winter the rust spores hibernate in the barberry bush, a shrub which was introduced into Canada to make hedges but which has since grown wild. Rust could be eliminated by destroying this bush but this is virtually impossible. It could be done away with by the very expensive process of dusting the growing crops with sulphur powder. Since the amount of infestation increases as the season advances, early-maturing crops escape some of the ravages of the pest. Maturity is speeded up by growing durum, or by early seeding of other varieties. The best and cheapest method of stopping losses from rust is undoubtedly breeding varieties of grain which are resistant to the fungus. As in the case of drought tolerance, this must be done without sacrifice of other desirable qualities. A further difficulty is that there are about 150 physiologic races of rust and a variety of grain which is resistant to some of them may be susceptible to others. Nevertheless, overcoming the rust menace by plant

[15]Craigie, J. H., *Stem Rust of Cereals* (Dom. Agric. Dept., 1940); Greaney, F. J., "Cereal Rust Losses in Western Canada", *Scientific Agriculture*, vol. 16, July, 1936, pp. 608-14; Güssow, H. T., and Conners, I. L., *Smut Diseases of Cultivated Plants* (Dom. Agric. Dept., 1927).

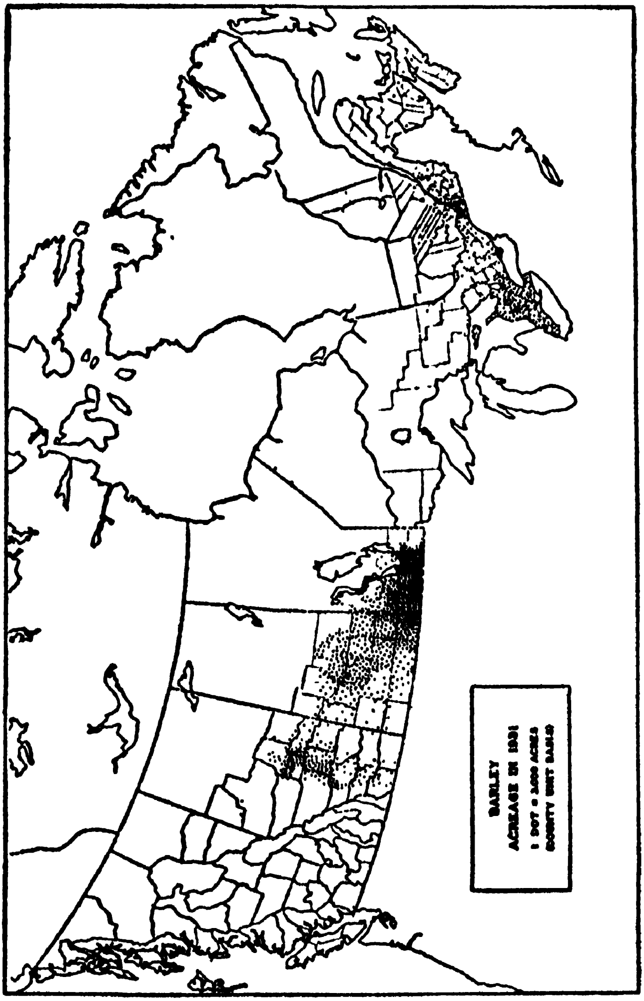
breeding has been attended by some success. Thatcher and Ajax wheats and Vanguard oats are resistant to most races of rust and reasonably satisfactory from the standpoint of baking qualities, yields per acre and so on.

Still another pest is grasshoppers.[16] The adult insects live chiefly off the leaves of field crops but will eat other types of foliage as well. Grain infested with grasshoppers may not mature at all or may become so badly lodged that it cannot be cut. The severity of the plague varies a good deal from one year to another. This is due to weather conditions, although the exact relationship is rather complicated. The insects can be destroyed by ploughing under or burning the grass and stubble containing the hibernating adults or by poisoning the mature grasshoppers with a mixture of bran, sawdust, salt, paris green, and water. Though notable advances have been made, the pest is not yet under control.

Another insect pest is the wheat stem saw-fly. In some years the devastating effects of the saw-fly are more serious than ruin caused by grasshoppers. The female saw-fly, after making a slit in the stem of the wheat plant, deposits her eggs within the stalk and when the eggs hatch out, the larvae consumes part of the stem from the inside. This action reduces the weight of the wheat produced per acre and lowers the quality about two commercial grades. Types of wheat which are resistant to the saw-fly are now being developed.

In the West weeds have become a serious menace. The usual means of control especially in Manitoba is by planting early-maturing crops like barley. This crop is harvested sufficiently early in the fall to enable the farmer to get on the land and kill the weeds by cultivation before they have gone to seed.

[16]Crawford, H. C., "Insects as a Factor in Wheat Production on the Canadian Prairies", *Canadian Geographical Journal*, vol. 18, April, 1939, pp. 217-24; Criddle, N., *Grasshopper Control in Canada East of the Rocky Mountains* (Dom. Agric. Dept., 1931).



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The crop in the following year can be planted on comparatively clean land. Weeds are one of the factors speeding up the shift to dairying on land not climatically unsuited to it. Better weed control results in having fewer extraneous seeds in commercial crops, makes more moisture available for paying crops and facilitates the operation of combines.

The development of drought-tolerant grains and the control of rust, grasshoppers and weeds must be accompanied by effective farming practices.[17] The early settlers from Eastern Canada and Britain soon discovered that the agricultural methods to which they were accustomed were inapplicable to Western conditions. In time, they began to use "dry farming" or summer fallowing, which is a system of agriculture suited to regions of low and uncertain rainfall. The principles of dry farming, though known for centuries by farmers in the dry areas around the Mediterranean Sea, seem to have been borrowed by Canadian farmers from the adjacent wheat districts in the United States. They were later brought into other parts of the Prairies independently by Mormons from the dry country in Utah and by Mennonites who came from southern Russia where similar conditions prevailed. Of course, farmers in the Middle Ages had permitted land to lie fallow every third or fourth year but the improvements in methods associated with the Agrarian Revolution made continuous cropping possible. Occasionally farmers in Eastern Canada had summer fallowed their land chiefly for the purpose of keeping down weeds. It is the widespread use of fallowing and the attempt to conserve moisture by this means that distinguishes dry farming from summer fallowing elsewhere.

[17]Barnes, S., *Soil Moisture and Crop Production under Dry Land Conditions in Western Canada* (Dom. Agric. Dept., 1938); Hopkins, E. S., "Cultural and Rotational Practices of Dry Land Agriculture", *Scientific Agriculture*, vol. 16, November, 1935, pp. 121-6; Stewart, A., "Changes in Methods of Agricultural Production in the Prairie Provinces", *supra*; Tinline, M. J., and Brown, D. A., *Summer Fallow in Manitoba* (Dom. Agric. Dept., 1938).

The original theoretical explanation of summer fallowing was that by not cultivating the land for one year except to keep down weeds almost all the precipitation in the fallow year could be retained within the soil and thus two years' rainfall would be available for one year's crop. Careful investigations have shown that summer fallow conserves only from 21 to 42 per cent of the previous year's moisture, the balance being evaporated by winds or used up by weeds. Yet even this saving is important in an area which is already close to the precipitation margin for commercial cereal production. The moisture conserved adds to the yield and quality of the crop in the following year and makes some contribution to the crops of later years as well. Summer fallow keeps down weeds—an important matter—and allows the stubble of previous years to decompose and add to the amount of food available for plants. It also permits weathering and micro-organisms to build up new supplies of nutriments. This is important in soils which are young geologically. In many years farmers find the autumn and spring seasons too short to permit preparing lands for crops and getting them sown at the best time for growth. Summer fallowing overcomes this difficulty by preparing the seed-bed well in advance.

Of course, no crop is raised in one year in the rotation and this loss must be set off against the higher yields and grades in the subsequent years. Growing a cash crop like oats in rotation with wheat has not generally proven profitable except in parts of the Park Belt. In Palliser's Triangle a crop of oats will usually provide some revenue above the cost of seeding and harvesting it. Also it is of some value in reducing soil drifting, though modern methods of summer fallowing are almost as good. Unfortunately, oats take so much moisture from the soil that the following crop of wheat is likely to be quite poor. The reduction in the return from wheat usually more than offsets the net income from the oats. For this reason the drier parts

of the Region alternate fallow and wheat on the soil. As one goes farther north the rotation may change to a three-year one—wheat, wheat, and fallow—but it is only in parts of the Park Belt which have higher rainfall, less evaporation and better soils that wheat, wheat, oats or some other continuous crop rotation is profitable. The best evidence of the value of summer fallowing is that, despite the complete loss of a crop in one year, the percentage of land in fallow appears to be increasing and in Manitoba now totals one quarter of the cultivated area.

If summer fallow is to be undertaken, it is important that it be conducted according to the best methods. Until about 1935 the usual practice was to cultivate relatively deeply either in the fall or, more generally, in the spring or early summer, followed by frequent surface cultivation with a disc. This practice was based on the theory that moisture contained in the soil immediately below the surface travelled upward along minute tubes between the particles of soil, a process known as capillary action. To stop this loss of moisture, the tops of the tubes were broken off by frequent discing and a fine mulch maintained on the surface. This theory has now been disproven. Moreover, when the fine mulch becomes unusually dry, as it did during the 1930's, the winds sweeping across the rolling plains blow the top-soil from the land in a dust storm which may be local or which may extend for hundreds of square miles.

Soil drifting is a serious matter. The soil carried by the wind onto the adjoining land may smother out growing crops. In particular, the remaining soil—that just below the surface—is less fertile than the top-soil for the reason that its organic matter is less and its mineral constituents are not as readily assimilable by plants. Soil drifting thus removes the most valuable elements of the soil. The loss to Western farmers as a result of soil drifting during the drought of the 1930's must be reckoned in millions of dollars. So long as the top-soil was bound together by the roots of

native grasses or covered by growing vegetation, soil drifting was limited, but when the binding material was removed by excessive cultivation or the foliage ceased to cover the ground on account of drought, the drifting of the top-soil reached serious proportions. It is obvious that the problem during the drought was aggravated by the presence on about one-quarter of the cultivated land of a fine mulch, the result of the older methods of summer fallowing.

The latest practice in summer fallowing is to use a duck-foot cultivator. Instead of pulverizing the soil as the older machines did, this machine stirs up only the top layer, piles the earth in little ridges from which the wind can drive less dust than if the ground were level, and places as many weeds and as much other trash as possible on the top of the soil so as to reduce evaporation and prevent drifting. The number of cultivations is kept to the minimum necessary to control weeds—two or three a year in the drier areas and four or five in the more humid ones. Summer fallowing has to be undertaken scientifically if full value is to be obtained from the practice and, in fact, if the farmer is to avoid doing more harm than good to his land.

It has already been pointed out that farmers in Eastern Canada, like most farmers elsewhere in the world, go to great pains to maintain the fertility of the soil by means of crop rotations and the application of animal or artificial fertilizers. But the Western farmer typically concentrates his productive efforts on raising wheat alone and uses fertilizers sparingly if at all.[18] The relatively small numbers of livestock raised in the West generally limits the amount of animal manure available. The

[18]Brown, A. L., Wyatt, F. A., and Newton, R. G., "Effects of Cultivation and Cropping on the Chemical Composition of some Western Canadian Prairie Soils", *Scientific Agriculture*, vol. 20, December, 1939, pp. 258-70: vol. 23, December, 1942, pp. 229-32; Neatby, K. W., "Soil Conservation in the Prairie Provinces", *Trans. Can. Conservation Assn.*, 1941, pp. 103-5; Stewart, A., "Changes in Methods", *op. cit.*

manure is expensive to apply and, in the relatively dry climate, the straw will not quickly disintegrate and thus become assimilable by plants. Formerly artificial fertilizers were high in price but their manufacture at Trail, British Columbia, and at Calgary, Alberta, may correct this condition. The low prices of grain have left the farmer with virtually no surplus with which to buy fertilizers.

A farmer really has two alternatives. He can apply fertilizers and so increase yields per acre. He gains from such a practice when the selling price of the increase in the number of bushels produced exceeds the cost of the fertilizer. On the contrary, he may use more and better machinery without applying fertilizer. In this case he reduces his costs because of the machinery though his yields may be slightly lower than what they were before. Nevertheless, he is better off than formerly provided his costs have been cut more than revenue has been reduced due to the lower total yield of the grain. Generally speaking, farmers have found it profitable to use the second alternative. There is no question but that natural or artificial fertilizers applied to wheat land increase yields in a physical sense but it has not yet been proven that under current prices for wheat the use of fertilizers is economically profitable, at least in the short run.

In the long run a serious situation may arise, because plant nutriments are being removed from the soil in the form of grain and straw and virtually no effort is being made to replenish them. Dark pictures have been painted of the calamity which will fall on Canada when Western soils become so impoverished that they cannot produce grain cheaply. "Soil mining" has been universally condemned. Qualified experts are still in doubt regarding the long run effect of the continued growth of the same product on Prairie soil but in general they have veered away from the pessimistic attitude of a generation ago. In their opinion the serious matter is not deterioration due to the removal

of nutriments by grain or by weeds harvested with it. Prairie soils are unusually rich in chemical constituents. Leaching and erosion are not problems, due to the low rainfall. There have been large losses of nitrogen as a result of cultivation but these have occurred chiefly in the first years of settlement and diminish considerably later on. The only really serious mineral deficiencies which have appeared up to the present are in the grey wooded soils in the north which are naturally of mediocre quality. So far as anyone can tell at the present time, declines in the yields of Prairie soils generally are not so likely to occur from the more or less continuous growth of wheat nor from the neglect to use fertilizers as they are from progressive infestation by weeds and from soil drifting caused by losses of organic matter (humus) as a result of drought or poor summer fallowing. More careful farming methods rather than more fertilizers seem to be what is required.

To sum up, Western agriculture is characterized by highly variable income due in part to fluctuations in the world prices for grain and mainly to climatic conditions. To guard against the human suffering and the financial loss which this variability entails, the farmers are urged to produce more of their own requirements and to diversify their output. Mixed farming has been adopted on only a limited scale throughout the West as a whole and is of considerable value only in a relatively few areas. To the extent that diversification can be carried on without loss in income to the farmers concerned, the production of animals and animal products should be encouraged. But the West is still basically a wheat country. Until means of changing the climate are discovered, it is likely to remain so. Man cannot change Nature; he can only co-operate with her to attain desired ends. The objective is the greatest long-run prosperity to the people of the Prairies. This end can probably be reached most

readily by raising the largest amount and the highest grade of the crop for which the West is climatically most suited.

In other words, public welfare can be best served by concentrating on the crop for the production of which the West has the greatest comparative advantage over other agricultural districts. The development of more drought-tolerant varieties of grain, the reduction of loss by rust, grasshoppers and weeds, and the improvement in methods of cultivation are of basic importance. It is not suggested that the wheat problem is solely a question of production. The need for extending markets abroad is also of vital importance. Nonetheless, appreciation of the geographic conditions of the West and of the crops most likely to grow in that environment are the basic determinants of national policy. An understanding of the economic and geographic factors in the situation will prevent the raising of false hopes and misdirection of effort.

What has been said applies to the West generally but conditions in both Palliser's Triangle and in the Peace River country are sufficiently different from the Region as a whole that they deserve separate consideration. Originally all the land in the Triangle was devoted to grazing and much of it, especially in Alberta, has remained a cattle country. Unfortunately attempts were made mainly just before and during the war of 1914-8 to grow wheat there. In some of these years the rainfall was better than average and in others the price of grain was high. After the war, both prices and precipitation returned to normal levels but farmers were able to carry on despite the fact that they had bought their land and equipment at wartime prices. Good and bad years alternated so that farmers were always able to survive a poor year or two until conditions improved. They also reduced their costs by using tractors and combines which were particularly well suited to this territory. Without the new machinery a farmer could handle only a relatively small acreage

because, even by hiring seasonal help, he could not harvest more than a certain number of acres between the date of the maturity of the grain and the early frosts and snow. The total crop from the limited acreage in a low-yield district gave the farmer only a small surplus after he had paid his expenses. This surplus was not large enough to support the farmer and his family throughout the year with the prices of grain at somewhere near their normal levels. By using the new machines, however, the farmer could cultivate enough land so that the total yield less expenses gave him a fairly reasonable standard of living except in years when the price of grain was abnormally depressed. Thus, by reducing costs and increasing the amount of land a farmer could handle, the new machinery permitted the continuance of cereal production in districts with low precipitation and even its extension into still drier areas.

In the 1930's farmers ran into increasing difficulties. In the short run these troubles were caused by drought and a drastic decline in wheat prices, but fundamentally precipitation in the south triangle along the Alberta-Saskatchewan line was not adequate to a wheat economy. The shortage of moisture was not basically due to a decade of drought. The average annual precipitation at Medicine Hat in the years 1929-34 was 12.2 inches compared with a 51-year annual average of 13.2 inches. When the long-run average is already close to the biological minimum for a crop even a small percentage decline from the average may be fatal to the profitable production of it. Variations in rainfall below the biological minimum are to be expected over a period of years and so the Triangle around Medicine Hat and Maple Creek should not be devoted to wheat growing on a commercial scale. Moreover, a succession of five years each with less than average precipitation is more serious than an alternation of good and bad years. The soil became so dry that drifting was pernicious. This was particularly detrimental on the light brown

soils of the south, where the grass cover is naturally sparse and the amount of slowly decaying vegetable matter binding the soil together smaller than toward the north. The farmer can "last out" a bad year if he soon gets a good year to make up for it but he may not have the capital or the physical stamina to pull through a series of bad years even though later on there may be a series of good ones. Also with continued cultivation grasshoppers, saw-flies and weeds become more serious.

Although wheat is climatically unsuited to parts of Palliser's Triangle, this fact was not realized until the 1930's. In that decade low yields or no yields at all coinciding with depressed prices caused distress to the farmers and widespread abandonment of farms. Once abandonment started it tended to be progressive. The cost of maintaining schools, roads, and telephone lines and the general expenses of government could not readily be cut. When some farmers left the land, practically the same total expenses for public services had to be borne by fewer taxpaying units. Hence, taxes per farm increased at the very time when low prices and low yields made the payment of taxes at even normal rates more difficult. Soil and weed seeds blew from abandoned farms onto the land of farms still in operation, further handicapping them and leading in turn to more abandonment.

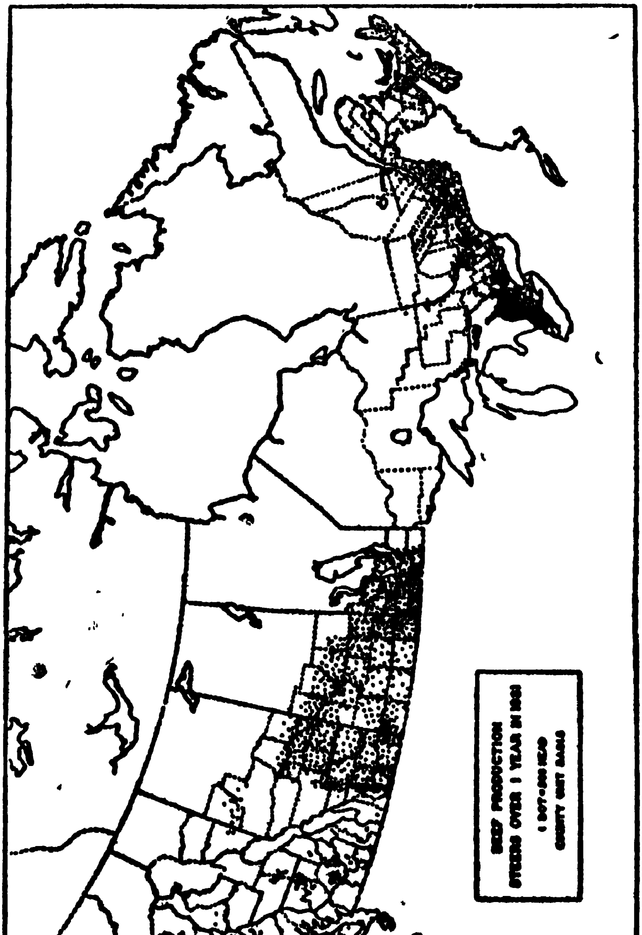
"The problems of the distressed area in this province [Alberta] are essentially problems in the use of resources. They can be stated generally in terms of vacant, idle, and abandoned land: of disused and dilapidated buildings: of depleted inventories: and of discouraged and defeated people. This situation and the associated conditions of accumulated indebtedness, tax delinquency, relief, and municipal bankruptcy, have arisen in general because producers in these areas have been unable to employ the resources at their disposal in such a way as to meet their commitments and provide for their own requirements and the

needs of a stable and developing community. Primarily the predominant cause may be inadequate rainfall, but immediately, it is to be found not in rainfall, soil, water, or other physical factors but in the inability of the producers to derive an adequate return from their operations".[19]

On land of this character little can be done except to re-establish it as a ranching district. On occasional farms with a little better soils or slightly better moisture conditions due to differences in local topography, wheat farming is possible though risky. Surrounding these crop lands are much larger areas which can be used only for beef cattle. The obvious programme for agriculture in this area is cattle raising, with some wheat growing in favoured locations.[20] In 1935 the Dominion government passed the Prairie Farm Rehabilitation Act. Under this legislation the federal government, with the consent of the provinces, purchased the occasional farms which still survive even though they have become isolated among the areas which have reverted to the various governments for unpaid taxes. The farmers so displaced are relocated on land which can grow crops. The area purchased from these farmers, along with land seized for non-payment of taxes, is carefully cultivated to keep down weeds and prevent soil drifting. It is then sown with grass seed or the natural grass is allowed to propagate. Once these community pastures, as they are called, have developed a good cover of grass they are leased to nearby farmers at a rental just high enough to cover the cost of operation. Every effort is made to prevent over-grazing, to stop the pasturing of so many animals on a given area that the grass cover is eaten very close to the ground. If this occurs propagation of the grass is stopped and soil drifting begins again.

[19]Stewart, *An Economic Survey*, *op. cit.*, p. 40.

[20]Archibald, E. S., "Prairie Farm Rehabilitation", *Canadian Geographical Journal*, vol. 21, October, 1940, pp. 173-92; "Prairie Rehabilitation", *C.S.T.A. Review*, December, 1939, *passim*.



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Native grasses re-seed very slowly and most of the grasses of Eastern Canada will not take hold properly except in unusually wet years. Western rye grass is reasonably good but the most suitable one is crested wheat grass,[21] a native of the plains or steppes of Russia and western Siberia, where climatic conditions are similar to those of the Canadian West. Crested wheat grass has a root system which covers an area about two feet across and may penetrate as much as eight feet if the soil is moist to that depth. The underground system is of great density, with a larger absorbing surface than the roots of other grasses. The abundance of root fibre makes the plant exceptionally drought tolerant, enables it to withstand close grazing, and prevents soil drifting. The grass tends to smother out weeds which generally cannot compete with it for moisture due to their smaller root structure. Crested wheat grass is also remarkably hardy, never being known to show frost injury in the West. It makes excellent pasture and forms a hay which is both nutritious and palatable to all classes of stock. The use of this grass and the establishment of community pastures are slowly rehabilitating the abandoned areas. Obviously it will be necessary to forbid the unwise extension of wheat growing again in future years.

Eventually parts of the Triangle with light brown soils, from Maple Creek and Medicine Hat south, will become permanently a livestock area like the foothills of southern Alberta where, except for occasional grain farms and irrigated lands, ranching has always been the typical industry.[22] This specialization has been due to the insufficiency of rainfall for cereals and the fact that

[21]Clark, S. E., and Heinricks, D. H., *Regrassing Abandoned Farms* (Dom. Dept. Agric., 1941); Kirk, L. E., Stevenson, T. M., and Clarke, S. E., *Crested Wheat Grass* (Dom. Dept. Agric., 1937).

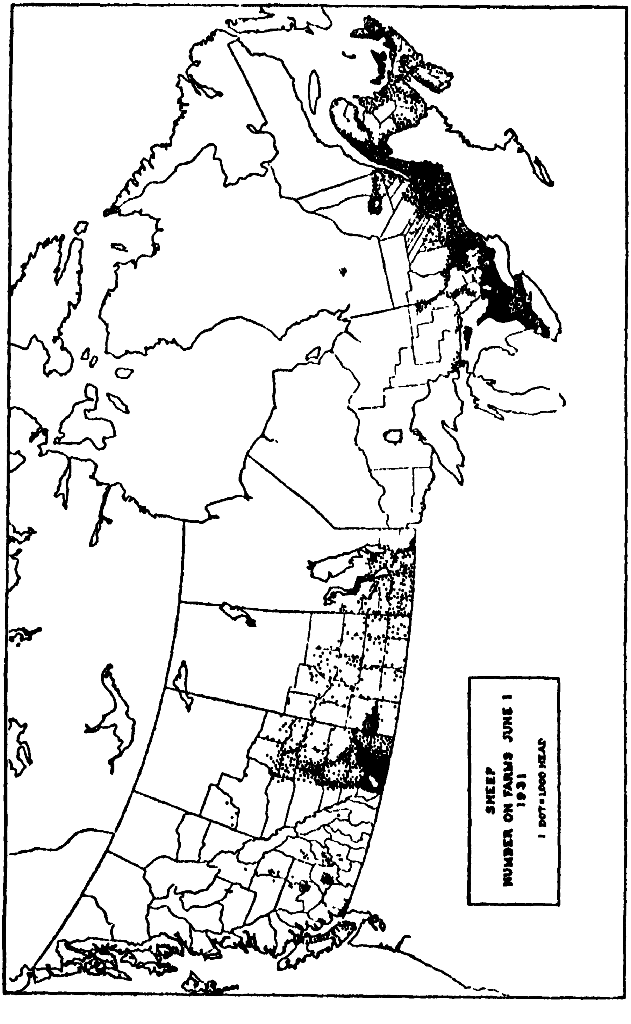
[22]Ely and Wehrwein, *op. cit.*, pp. 231-47; De Long, *op. cit.;* Kindt, L. E., "Economic Status of the Range Sheep Industry", *Proceedings, Canadian Society of Agricultural Economists,* 1933, pp. 69-81; "The Range Sheep Industry", *Economic Annalist,* vol. 2, January, 1932, pp. 4-6.

the land is often too rolling for the easy operation of farm machinery. In the Triangle, including the foothills, the ranchman's chief problem is getting an adequate supply of cheap high-grade pasture for his stock. Land adjacent to water courses is typically expensive, while districts remote from water or near saline lakes are avoided. Land which at one time was in field crops or which is considered by its owner to be suitable for crops is burdened with taxes and interest charges out of proportion to the amounts which are suitable for ranching. Other land is held by absentee owners who have exaggerated ideas of its value.

The high cost of land forces ranchmen to pasture all the stock they can on it in order to make ends meet. The result is over-grazing. A larger number of livestock is carried on the land than the grass will properly support. Sooner or later the grass cover deteriorates; weeds become prevalent and soil drifting may begin. The quality of both livestock and land degenerates. If the ranchman keeps a herd which is just large enough so that it can be handled in years of poor rainfall, he feels that he is losing money because the herd is smaller than the number which can be accommodated in good years. In order to ensure getting as large profits as he can, at least in the short run, the ranchman tends regularly to keep his herd at the maximum carrying capacity of the range. When precipitation declines, the evils of over-grazing are inevitable. Most ranchmen lease their land on yearly contracts. If an individual ranchman takes pains to see that his land is not over-grazed and so builds up the quality of the grass, he may find himself outbid in the following year by some other ranchman who wants better pasture for his stock. The high cost of land, the desire to maximize profits by carrying as large a herd on the land at all times as it is possible to do in years of good rainfall, and finally, the insecurity of tenure, all lead to over-grazing.

On provincially owned lands in Alberta the government has a new type of lease which gives more or less permanence of tenure and in which the rent varies with the selling price of beef. There is no need to meet an annual rent which is fixed in amount. This removes the temptation to pasture a large number of cattle so that, after paying the rent, there will still be a good surplus even when prices are low.

The ranches in southern Alberta and Saskatchewan raise either cattle or sheep. Rarely are both raised on the same ranch because each animal has its own peculiar production problems. In the early days, when the range was free and grass plentiful, the beef cattle spent the entire winter outside. This is still physically possible because the native grasses mature or cure on the stem and provide good fodder throughout the year. The warm Chinooks melt the snow from time to time so that the cover is never of such a depth that the cattle cannot scrape it back with their hooves to get to the feed underneath. But now that more cattle are being raised, it is profitable to put them in stables or at least shelter them near buildings for four or five months each winter and supply them with hay brought in from farming, as distinct from ranching districts. Stock fed in this way is kept in better condition than purely range-fed animals. By taking the cattle off the range early in the fall, a good carry-over of grass is left during the winter and a much larger amount of nutriment is available in the following spring and summer than if the range had been grazed continuously. In order to avoid part of the heavy expenses of feeding all his stock on hay throughout the winter, the ranchman sells most of the mature animals in the early fall when the cattle, having pastured on succulent grass during the summer, are of good weight and quality. The ranchman must be careful to dispose of his beef cattle from the range at the proper time. An early snow or a deficiency in rainfall may cause so much shrinkage in weight and



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lowering of quality in the cattle that only long and expensive feeding can offset it.

Sheep ranching is carried on at various points in the foothills and Palliser's Triangle, such as Maple Creek, Medicine Hat, Lethbridge and Macleod. Throughout the world sheep are typically raised on drier lands than cattle because their water requirements are less and they are able to crop very closely to the ground, due to their cleft or hare lip. There is only slight evidence of this climatic adaptation in the Canadian West. Although on the sheep ranches the grass cover is thin, as much as nine acres of pasture being required on some ranches for an adult sheep, the sheep ranches are surrounded by cattle ranges and the choice of one or other animal is apparently determined by accident rather than by scientific adjustment to environment.

The typical sheep ranch is much larger than the average grain farm. Some ranches have 12,000 acres of land and 1,700 sheep. The average ranch derives about one-third of its revenue from wool and the remainder from the sale of lambs and ewes for mutton and breeding purposes. Normally most of the animals are sold in the fall after having been brought to first-class condition on the cheap grasses of the range, but increasing numbers of lambs are sent from the range to the mixed farms of the St. Lawrence Lowlands where they are fattened for market. Lamb and mutton now reach the consumer in better condition and at all seasons of the year, whereas formerly these meats were almost unattainable except in the fall. With marketing spread out more evenly throughout the year, prices for sheep and lambs on the farms have improved.

In a low precipitation district like the Triangle the attention of settlers was quickly turned to the possibilities of irrigation.[28]

[28] "The Water Supply of the Prairie Provinces", *Engineering Journal*, vol. 18, April, 1935, pp. 171-231; Brown, R. H., "Irrigation in a Dry Farming Area", *Geographical Review*, vol. 24, October, 1934, pp. 596-604;

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Some of the early ranchers dammed back the creeks in order to flood the nearby low-lying lands. They were able to grow hay for use by their stock during the winter. Soon larger projects, designed primarily for farming rather than as simply supplements to ranching, were started. At present there are 12 large and nearly 350 small private projects in southern Alberta, with a few in Saskatchewan. The total area which it is now possible to supply with irrigation water is about one million acres. The more important projects are near Calgary, Lethbridge, Vauxhall, Taber, Magrath, and Raymond.

The fundamental economic problem in connection with all irrigation projects is the difficulty of meeting the high cost of constructing and maintaining the engineering works required. The total investment in irrigation facilities in Alberta is about $35,000,000. The annual interest charges plus the cost of repairing the facilities and pumping the water into the flumes varies from two to five dollars per acre. If the irrigated land is to meet all the expenses involved in its creation it must produce a yield per acre higher than the yield on non-irrigated land by an amount large enough to cover the costs of irrigation.

One would suppose that the possibility of adding water at will, of controlling, so to speak, one of the elements of weather would invariably result in high yields or superior quality or both so that the extra costs would be easily met. As a matter

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Buchanan, D. W., "Planned Sugar Beet Production in Alberta", *Canadian Papers* (Toronto: Canadian Institute of International Affairs, 1933), pp. 96-9; Burchill, C. S., "The Eastern Irrigation District", *C.J.E.P.S.*, vol. 5, May, 1939, pp. 206-15; Eisenhauer, E. E., "Irrigation in Alberta", *Scientific Agriculture*, vol. 16, January, 1936, pp. 270-4; Ely and Wehrwein, *op. cit.*, pp. 247-70; Hedges, J. B., *Building the Canadian West* (New York: The Macmillan Company, 1939), *passim*; Palmer, A. E., *The Use of Irrigation in Farm Crops* (Dom. Dept. Agric., 1929); "Possibilities of Settlement of Irrigated Lands in Alberta", *Scientific Agriculture*, vol. 23, December, 1942, pp. 200-4; Peters, F. H., "Mountain Water for Prairie Grassland", *Engineering Journal*, vol. 21, January, 1939, pp. 13-8; St. Mary and Milk Rivers Water Development Commission, *Report* (Ottawa: 1942).

of fact the higher charges are rarely covered because irrigated lands are not sufficiently better producers than non-irrigated ones. The only projects likely to pay for themselves are those raising goods like dates and oranges which cannot usually be grown without irrigation, or producing foods such as early vegetables which come on the market when similar articles from other areas are not available.

Sometimes irrigated areas raise crops for which there is a strong local demand and then send out these crops in valuable, concentrated form. A good example of the last type is alfalfa, which supplies two or three crops of very nutritious hay per year. This can be sold at good prices to nearby ranchers for feeding during the winter to cattle which have been kept on the natural grass of the range during the summer. Alfalfa has a sort of monopoly in supplying this important market. Its only competitor is hay which, though it may have been grown where climatic conditions are very favourable, has to be hauled into the grazing areas over long distances and at great expense. Alfalfa sends roots deep into the soil and is remarkably drought tolerant provided it can get a good start. Consequently, its water requirements can be met with less expense for irrigation than other crops. It has the added advantage that it absorbs nitrogen from the air and stores it in nodules along its roots. This nitrogen is in easily available form for succeeding crops. The chief limitations on the growth of alfalfa are the number of cattle that can be carried on the summer range and the price ranchmen can afford to pay for it. If alfalfa is too expensive, ranchmen may not be able to sell their cattle in distant markets in competition with cattle which have been raised where feed can be produced plentifully and cheaply due to better climate.

The possibility of raising crops on the irrigated land of southern Alberta which do not compete with those grown on nearby non-irrigated lands is small. In southern California

citrus fruits and in British Columbia apples provide a suitable non-competitive product; but the general climate of Alberta restricts the range of products which can be grown under irrigation to alfalfa, grain, potatoes, and sugar beets. Grain raised on irrigated land is often two commercial grades lower in quality than that raised on nearby non-irrigated districts for the reason that, unless the artificial supply of water is very carefully controlled, the gluten content of the wheat drops. Neither the quality of wheat nor the yield per acre is high enough on irrigated land to justify the use of this expensive soil. Although potatoes are superior, they are bulky, cannot easily be concentrated and so the market for them is small.

Fortunately sugar beets satisfy nearly all the necessary requirements of an irrigated land product. They cannot readily be grown elsewhere on the Prairies and the extraction of the sugar from the beet condenses the product before sale. The pulp which remains after the sugar is removed makes excellent cattle feed. The cultivation of beets keeps down the weeds and effectively prepares the ground for other crops. Although there is competition with sugar obtained from cane, the distance of the cane fields from the Prairie consumer and the existence of a high tariff against cane sugar tends to lessen the trade rivalry. The fact that a Vancouver refiner of sugar cane also owns a sugar beet factory in Alberta would seem to indicate that the competition between cane and beet sugar in the West is not intense. In view of all these advantages, it is not surprising that sugar beets form the backbone of the economy of irrigated lands in Alberta.

The expansion of the sugar beet industry is restricted by the difficulty of getting ample supplies of cheap willing labour to thin, hoe, and harvest the beets. Beets are bulky and relatively low-value articles and cannot be economically shipped more than a distance of 20 or 30 miles. In order to have a chance of

covering its expenses, a sugar refinery must be large in size. Small refineries do not pay because the expensive machinery which they need is used at less than full capacity, and so the interest and depreciation charges per pound of sugar produced are excessive. This means that the smaller irrigated areas cannot raise beets since they can neither support a refinery of their own nor afford to send their beets long distances to outside refineries. Finally, so much land has already been irrigated that it is not worth while to use all of it for beets. Meanwhile the other irrigated land struggles along raising products, except alfalfa, which compete with those grown on non-irrigated land. Under these conditions farmers in many areas are not able to get an income high enough to cover the cost of constructing and maintaining the irrigation facilities.

A few of the irrigated districts have been financially successful but most of them have been unprofitable. At Taber, 35 miles east of Lethbridge, 21,000 acres of land have been irrigated at a cost of $13 per acre. The land is being used, in about equal proportions, for grain, for sugar beets and canning vegetables, and for hay and pasture. The typical farm of 69 acres is smaller than in purely grain-growing districts. Though there has been some deferment of the annual payments of interest and principal on the capital cost, there has been no widespread default. Success has been due to an ample supply of water from the St. Mary River and to relatively low operating and capital costs.

On the other hand, the cost of irrigating 96,000 acres on the Oldman River near Macleod was $55 an acre. This high capital cost was due in part to an unprecedented flood which destroyed some of the works soon after they were completed in 1923. Even if the disaster had not occurred, it is doubtful if the land could have carried the expenditure on permanent facilities. In any case, the government of Alberta has had to assume 70 per cent of the total cost. Although the district pro-

vides winter feed for 6,000 cattle and 22,000 sheep raised on nearby ranches, the cost of the works is still an almost intolerable burden. In years with better than average rainfall the precipitation is adequate for most crops except sugar beets and vegetables. The farmer always hopes for enough rain for cereals and alfalfa since he gets rainfall without cost. Sometimes he postpones buying irrigation water until so late in the season that the application of moisture artificially will do his crops no good. As one economic geographer has put it, farmers in these areas would rather pray for rain than pay for water.

When only a few farmers along a ditch use water, their costs are increased because they have to pay the full cost of the facilities built past farms which depend on rainfall. A project will cover its costs only when the number of acres irrigated per mile of main trunk ditch is quite large. Products like sugar beets, which require water in comparatively large amounts every year, are most likely to cover the costs of irrigation. Since this is true, paying irrigation projects will be confined to relatively small areas and will depend on the demand for sugar, the supply of labour for thinning and lifting the beets, and the existence of a nearby sugar refinery. Other districts are not likely to pay in themselves though they may help adjacent ranching areas by providing winter feed.

Despite the financial failure of most of the projects to date, elaborate plans are being made for irrigating many more acres after the present war. These cannot be justified on purely economic grounds though they may be condoned because they will help in post-war rehabilitation, result in savings to the public by cutting down on relief payments during periods of drought, and give a feeling of stability to Prairie farmers in bad years.

Like Palliser's Triangle, the Peace River country[24] has some-

[24]Albright, W. D., "Past, Present and Future of the Peace", *Canadian Geographical Journal*, vol. 16, March, 1938, pp. 127-38; Albright, W. D.,

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what different characteristics than the Prairies as a whole and therefore is entitled to separate attention. The river existed prior to the period of uplift which created the Rocky Mountains. Because this uplift occurred slowly, the Peace was able to maintain its course by cutting a deep trench into the mountains and the foothills. Thus the Peace, rising west of the Rockies, flows through them in a deep canyon, to emerge in the foothills at a depth of about 800 feet below the general level of the land. The depth of the trench declines to about 100 feet at Fort Vermilion due to the smaller amount of uplift as one goes eastward from the Rockies. The Peace River country at present appears as a gently rolling plateau with ruling elevations of between 1,800 and 2,500 feet above sea level, dipping toward the northeast and deeply cut by the channels of the Peace and its tributaries.

The climate of the Peace River country is suitable for grain growing. The winters are no colder than in other parts of the settled West and the summers are as warm as in southern Alberta. Although the frost-free season is about 100 days, frost merely restricts the selection of crops but otherwise does not handicap production. In the areas already settled frost has never been serious enough to cause more than small injury to grain. Early snow and heavy rain during harvest sometimes reduce yields. World's championships for both wheat and oats have several times been won by farmers in this district. It is sometimes asserted, however, that Peace River grain is of excellent appearance on account of its plump kernels and good colour but does not have as high protein content nor make as good bread as grains raised elsewhere in the West.

"The Menace of Water Erosion in the Peace", *Scientific Agriculture*, vol. 19, January, 1939, pp. 241-8; Dawson, C. A., *The Settlement of the Peace River Country* (Toronto: The Macmillan Company of Canada Limited, 1934); Kitto, F. H., *The Peace River Country, Canada* (Ottawa: Dept. of Interior, 1927); Leppard, H. M., "The Settlement of the Peace River Country", *Geographical Review*, vol. 25, January, 1935, pp. 62-78; Mackintosh, *op. cit.*, pp. 151-71.

The native vegetation consists of thick stands of white spruce and scrub poplar alternating with grassy treeless tracts varying in size from a few square miles to 100 or more. These "islands", locally known as "prairies", form the centres of settlement because they are easily arable and have good-quality soils. On the forested lands the soils—typical podzols—are not high grade, being coarse, crumbly, and deficient in phosphates and nitrogen. The reason for this condition is that rock particles disintegrate slowly in the cool climate and, more especially, the roots, trunk, limbs and leaves of the trees decompose so gradually that the precipitation is able to leach them of their nutritive elements. In an unfertilized state these podzols yield only about half the number of bushels per acre as the black soils in the nearby "prairies". They can be improved by applying artificial fertilizers and by growing clover but this is not profitable under current price conditions. Of the 74,000,000 acres drained by the Peace the high-grade soils totalling 5 per cent of the total and the better second-grade soils with 7½ per cent have already been partially occupied. The erosion of the soil by running water is a menace to agriculture in some localities.

Aside from the existence of much low-quality soil, the Peace suffers from the fact that the areas with good soils are scattered and transportation is expensive. Railways and highways have to penetrate through many miles of thick forests with their low grade podzols in order to tap the scattered "prairies". This greatly increases costs and means that small, remote "prairies" are never developed at all or else carry on from 20 to 75 miles from a railway in a state of economic anaemia. The existence of the deep trenches along the rivers prevents communication from one bank to the other and isolates communities. The trenches also mean that it is difficult to use the rivers for transportation purposes. Furthermore, the Peace is shallow in the autumn when rains do not fall in the mountains. Its channel is

often clogged with sand-bars. Finally, the Peace River country is separated from Edmonton by a wide district of poor soils. Grande Prairie is nearly 1,200 miles by rail from Vancouver and over twice that distance from Montreal. The export rate on grain is only slightly more than that from Edmonton but on other products and on inward freight the rate is somewhat higher. The demand for cheaper transportation, particularly for an outlet directly to the Pacific through Prince Rupert, Vancouver and even Stewart is insistent. From some points of view the cost of transportation is but a reflection of the dispersion of the fertile soils rather than a basic problem.

Long heralded as the "Last Great West", the Peace River country now has 50,000 settlers occupying 3,500,000 acres of land. From 40 to 70 per cent of the field-crop acreage is devoted to wheat and from 20 to 40 per cent to oats. Most of the wheat is exported as grain but some wheat and all the oats are concentrated in the form of hogs and cattle in order to give a product better able to stand the high transportation charges to market. On the whole, hogs have been found to be more satisfactory than cattle in this district because their need for drinking water is less and, since they mature much more quickly than cattle, only a few of the animals need to be kept throughout the long winters.

The precipitation is always adequate for crops but securing a supply of water for drinking by animals and humans is often a problem. The rainfall, which averages about 16 inches per annum, sinks quickly into the deep soil cover. Water is hard to get from dug or surface wells. Wells deep enough to tap the rock underneath are sometimes successful but where the underlying formations are marine, the water is bad. It is too expensive to draw water from the deeply entrenched rivers, and unsatisfactory to drive the cattle down the steep banks to the stream. Usually the smaller streams are dammed up and perhaps lined

with clay to prevent seepage. Depressions and the valleys of small creeks are deepened and broadened to form surface "dugouts" which prevent the run-off of water and store it for use. A few families store ice to supply their own drinking water during the summer.

The Peace River country is still definitely a pioneer area even though farmers in the older settled parts have about the same annual net income as those south of Edmonton. The future of the district seems to hinge on securing better transportation, improving our methods of using low-grade soils, and perhaps securing close markets in mining camps. The remoteness of the area from overseas export markets and the scattered character of the fertile soils will constitute permanent handicaps on development.

The probable northern limit of agriculture in the Prairie Region is a topic of perennial interest to Canadians.[25] Over the past few generations farming has been steadily pushed northward. This has been partly due to the development of new varieties of wheat. The growing industrialization of Europe and America has created large markets. The steady cheapening of transportation on land, Great Lakes and ocean has also aided the northwards shift. Whether a favourable conjuncture of these factors will occur in future years and permit a still further expansion northward is a matter to which, obviously, no definite answer can be given.

The climatic limit for the growth of the present varieties of wheat appears to be the isotherm of 70 degrees Fahrenheit during the month of July. This isotherm lies not far north of the present railway network, ignoring the spur to Churchill on Hudson Bay and to Waterways near the junction of the Clearwater and the Athabaska. Of course, the development of types

[25]MacGibbon, D. A., "Adaptation of Wheat to Northern Regions", *Pacific Affairs*, vol. 7, December, 1934, pp. 415-24.

of wheat and coarse grains with short-maturing seasons may extend the northern limit as did Marquis in the early years of this century. The difficulties of plant breeding have already been pointed out. The Russians claim[26] to have solved the problem of growing wheat in cold climates by planting just before the first frost in the fall. The seeds do not sprout before cold weather sets in and they endure the most severe cold without injury. In the spring they sprout thickly and evenly and produce good yields early in the fall before there is any danger of frost damage. Whether such methods are practicable in Canada remains to be seen.

With the present varieties and farming methods in the area beyond isotherm 70 degrees in July, frost destroys, on the average, about one crop in five and seriously reduces the yield and grade of another. The averages are somewhat misleading for the frosts may kill the growing crops for two or three years together. Although it is possible to determine the frequency of frost over a period of years, it is not possible to forecast whether in any specific year there will be a crop failure or not. The farmer has to go to all the expense of preparing the ground and planting the seed. If there is no crop for two or three consecutive years the farmer may exhaust all his reserves before he gets a crop at all. After a couple of crop failures he may decide to reduce his acreage or, losing courage, he may cultivate the land only half-heartedly. If this year should happen to be a good one he will be unprepared to take advantage of the only chance he had to rehabilitate himself. If the farmer could only rely on average conditions he could probably manage. But the arithmetic average is a deceiving thing and the farmer may die economically before he lives long enough to experience "average" conditions.

[26]Mosolov, V., "Growing Wheat in Eastern Russia", *C.S.T.A. Review*, December, 1942, pp. 25-7.

A stable economy can only be achieved if agriculture is adapted to the entire range of climatic conditions.

In addition to climate, soils and the cost of clearing and of transportation raise difficulties to the northward extension of cereal growing. The soils can be improved but only at some expense which it does not pay to incur under present prices.[27] Even if prices were to rise substantially, most of these low-grade soils would not be used, because there are large areas of equally rich soils which are more favourably located with reference to markets and which are at present unused. Also, just beyond the present northern limits of the railways in the Prairies, the forest cover thickens somewhat. The trees are no larger in size than farther south but are more numerous and hide a larger proportion of the total area. Conversely the area of grass land decreases. As one goes still farther north, the country loses its park-like character entirely and merges into the continuous forest to be discussed under the Canadian Shield. The greater density of the forest increases the cost of clearing the land. Although in total there is probably to the north of the existing railways a considerable acreage of moderately good soils which could be cheaply cleared, they are so interspersed with mediocre and definitely poor soils that it does not pay to construct railways to reach them. Transportation is a problem but if climate and soils were satisfactory, this difficulty could be solved.

It must be emphasized that the economic limit of settlement is not a static thing. It is constantly being altered by changes in selling prices and in the cost of production, by the development of new techniques in farming and in transportation, by the decline or revival of producing areas elsewhere, by the perfection of new varieties of plants, by changes in the purchasing power

[27]Mitchell, J., and Moss, H. C., "Problems of Land Settlement in Saskatchewan", *Scientific Agriculture*, vol. 23, December, 1942, pp. 195-9; Wyatt, F. A., "Fertilizers for the Black and Gray Soils of Central Alberta", *ibid.*, vol. 16, January, 1936, pp. 238-40.

and diet of foreign peoples especially in the Orient, and by the tariff policy of the United States and European countries. In particular it might be altered by the willingness of Canadians to admit to the Dominion people of alien race, language, and religion. These people might be able to develop the marginal lands and wrest from them a living as good or better than that to which they have been accustomed in central Europe. So far, Canadians have not welcomed these people in large numbers. Unless this national attitude changes, the Prairies have already about reached the limit of their agricultural development. Only a drastic change in one basic factor such as the foreign market for wheat or else the favourable concurrence of a number of minor factors will alter this generalization.[28]

The lay-out of farm lands and the proportion of tenant farmers on the Prairies is in marked contrast to conditions in the Lowlands of Ontario and Quebec. In the West the farm land is divided into townships each containing 36 sections. Each section is as nearly one mile square as is permitted by the convergence of the meridians as they go northward. From time to time adjustments have to be introduced to allow for this convergence, as the boundary line between Manitoba and Saskatchewan on a detailed map shows. Each section contains 640 acres and sometimes is divided into quarter- and half-sections. Road allowances run north and south between each section and east and west at distances of two miles apart.

In the wheat-growing districts of the Central Plains 20 per cent of the farms are quarter-sections or smaller, and 27 per cent full sections or larger. In the Park Belt the farms tend to be smaller with 37 per cent being one quarter-section or less

[28]Joerg, W. L. G., ed., *Pioneer Settlement* (New York: American Geographical Society, 1932), pp. 1-49; Mackintosh, W. A., *op. cit.*, pp 136-50, 172-85; Waines, W. J., "Prairie Population Possibilities", a Study prepared for the Royal Commission on Dominion-Provincial Relations (Ottawa: 1940).

and only 12 per cent a full section or more. In the grazing districts of the south the typical farm is several sections in size. The difference in the relative size of the farms is due to the fact that grazing requires a larger area to supply a livelihood to the farm operator and his family than does wheat growing. Wheat growing, in turn, necessitates a larger farm than the more mixed type of agriculture carried on in the Park Belt. Also, the number of farmers of recent Central European origin tends to be higher farther north than in the south and new immigrants seem to prefer farms which, though large judged by European standards, are small with reference to the highly mechanized farms of the central Canadian Prairies. With the steady trend toward the more extensive use of the tractor and combine, the farms are generally increasing in size over the years.

In 1901 of the 55,000 farm holdings in the three Prairie provinces about 92 per cent were operated by their owners, the remainder being operated by tenants or were part owned and part rented. The high percentage of ownership was due mainly to the ease with which public or crown land could be "homesteaded". After occupying the land for three years, erecting a habitable house and cultivating at least 30 acres of land per quarter-section, the homesteader could obtain a clear title to the land for a very nominal fee. By 1931 only 69 per cent of the 288,000 farm holdings were being cultivated by their owners. The rapid growth in tenancy in the West was due to the higher cost of farms because of the rise in land values, the growth in the size of the typical farm, and the substitution of expensive machinery for human and animal labour. The greater cost of farms and farm equipment makes it more difficult for a farmer to "graduate" from tenancy to outright ownership. The existence of drought and low prices for grain in the later 1930's further postponed ownership by tenant farmers. In the same period many farms were abandoned by their original owners

and some of these farms were operated by tenants who rented them from the insurance company, loan company or other mortgagee. With greater mechanization and larger farms many operators are renting land in addition to the land which they own and work. Thus, for census purposes, there is an increase in the number of farms in the part-owned, part-operated class. The proportion of tenancy varies with different ethnic groups. In particular the Slavs cling to ownership because of tradition in the lands from which they came. There are a few "suit-case" farmers, farm operators who live in the cities during the winter and occupy their farms only during the planting and harvesting seasons. This part-time farming is made possible because there is no need to feed livestock or draught animals when wheat alone is raised and produced by power-driven machinery.

The increase in tenancy may have far-reaching effects. As a general rule the tenant is less concerned with adequately maintaining buildings and preserving the fertility of the soil than is the owner, because he has not a permanent interest in the land. He is more likely to abandon the farm when the relationship between costs and prices becomes unfavourable. He tends to become shiftless. He moves from farm to farm, depleting each one of as much fertility as he can before he moves elsewhere. Of course, he may decide to buy a farm. If he does so when prices are high, he may suffer severely when prices fall. He owes the same number of dollars as he did before but it takes a much larger number of bushels of low-priced wheat to pay the cost of the farm than formerly. This situation has led governments in the Prairies to pass legislation postponing payments of interest and principal in poor crop years. This legislation has undoubtedly relieved farmers of pressing obligations in times of depression but it may have discouraged investment in agriculture and in trade generally, and has weakened the confidence of foreign investors in the soundness of Canadian securities.

Forestry

In view of the treeless character of most of the Prairie Region it is not to be expected that forestry will be an important industry. Even so, settlers in the Park Belt are able to make use of the aspen, spruce and other softwoods there as well as in the adjacent parts of the Shield. Elsewhere, farmers use the poplar of the bluffs and the white spruce and aspen of the Riding Mountains. These local supplies are not nearly large enough to satisfy the demand of the West for lumber but they do provide cheap fuel, fence posts and building materials to farmers fortunate to be located close to them.[29]

In order to beautify Prairie homes and eventually supply more of the local needs, governments have been encouraging tree planting.[30] Indeed, there have been proposals to plant belts of trees, miles in length, and about 400 yards apart, with the object of making the output of wheat more certain. It is claimed that the trees would collect and hold the snow, force it to melt more slowly and hence make more of it available for plant growth. Trees would prevent rapid run off after rains, limit the amount of evaporation by the hot winds during the summer, and stop soil-drifting in periods of drought. This scheme, admirable though it is in theory, overlooks the difficulty of getting trees started in the Prairies except in years of higher than average rainfall. Also the soils immediately beneath the top-soil are unusually compact and need to be specially prepared for trees. Tree belts divide up the land into smaller fields that cannot be cheaply worked with machinery. Most important of all, the land is more profitably devoted to field crops. Despite the low

[29]Harrison, J. D. B., *The Forests of Manitoba* (Ottawa: Forestry Branch, 1934); Harrison, J. D. B., *Forests and Forest Industries of the Prairie Provinces* (Ottawa: Forestry Branch, 1936); Stevenson, H. I., *The Forests of Manitoba* (Winnipeg: Manitoba Economic Survey Board, 1938).

[30]Ross, N. M., "The Role of Trees in Modifying the Agriculture of the Dry Areas of the Prairie Provinces", *Scientific Agriculture*, vol. 16, January, 1936, pp. 266-9; *Tree Planting on the Prairies* (Dom. Dept. Agric., 1933).

yields in drought years, the use of all the land for wheat is likely to give a larger net income over a period of years than would slightly higher yields on the parts of the land between the belts of trees over the same period.

Mining

The mineral resources of the Prairie Region are confined to those which are found in flat-lying sedimentary rocks. The most valuable of these is coal.[81] In fact the reserves of coal are literally enormous. Estimates made by the World's Mining Congress in 1913 credited Alberta, including deposits in the Cordillera section of the province, with 1,000,000 million tons or 14 per cent of the world's total. This estimate is undoubtedly much exaggerated—perhaps 50 times too high—but the reserves are huge nonetheless. Moreover, there are large amounts in Saskatchewan and Manitoba and on the face of it these should provide the basis for a widespread industrial development.

Coal is mined at Nordegg, at Brulé Lake, at Cardiff near Edmonton, at Coalspur in the foothills of the Rockies, along the Belly River not far from Lethbridge, at Drumheller 75 miles northeast of Calgary, near Estevan and Bienfait in Saskatchewan, and in southwestern Manitoba. In general, the highest grades, good-quality bituminous, are found in the foothills, with lower-grade bituminous and finally lignite farther eastward in the plains.

Notwithstanding the tremendous quantity present in the Prairie Region, coal is of only moderate significance in the economy of the Region and has given rise to almost no industrial development. The basic reason for this anomalous condition is the poor quality of much of the coal. Only limited amounts, probably not more than five per cent, are suitable for coking under existing methods. In the coking or carbonizing process,

[81]Moore, *op. cit.*, pp. 172-9; Young, *op. cit.*, pp. 128-41; Campbell, C. M., "Coal Reserves of Canada", *Economic Geology*, vol. 35, July, 1940, pp. 670-4.

coal is decomposed by heat in the complete absence or with a limited supply of air. In this way it is converted into four products; either coke or char, depending on the carbon content of the original coal, an organic liquid compound or tar, a watery liquid called ammonia liquor, and gas. The potential heat values of all the four products must be less than the potential thermal content of the coal placed in the coking furnace. This is necessarily true because of the heat required for operating the process itself.

The quality of the coke and other products is dependent basically on the quality of the coal used. Due to their poor character, the great bulk of Prairie Region coals are not suitable for the production of high-grade coke.[32] Many attempts have been made throughout the world to make good coke from poor or mediocre coal but none of these has been commercially successful. Lignites are used for coke in Germany but they appear to be of better quality than much of the Prairie coal. A further difficulty is that a coking plant with the necessary equipment for recovering all the by-products involves a large capital outlay. The expenditures cannot be justified unless there is a steady market for the full output of at least two of coke, tar, and gas. Up to the present no market of this kind exists in the West. Even if it did, the poor quality of most of the coals would put an insuperable barrier in the way of coking unless, of course, radically different and much cheaper processes for carbonizing low-grade coals are discovered. In the latter event many other countries would share the benefits of the new technology with Canada.

Briquetting is another process for improving low-grade coals. The coal is ground or powdered, heated slightly and thoroughly mixed with bitumen, coal tar or some other binding material.

[32]Stansfield, E., "Carbonization and Briquetting of Alberta Coal", *Trans. C.I.M.M.*, 1937, pp. 35-44.

It is then pressed and moulded into lumps. The briquettes are cleaner, easier to handle, and have a higher heating value than the coal from which they are made on account of the addition of the combustible binder. The process is expensive though the use of bitumen from the tar sands along the Athabaska River may at some future time reduce the present cost somewhat.

Most coal currently being mined in this Region is sold in its raw state for heating homes and other buildings, for general steam-raising purposes, and for railway use. Only limited quantities can be sent into the large market in Ontario, due to distance and the superior quality of American coals. Even in Winnipeg there is intense competition with anthracite coal from the Pennsylvania coal mines. This coal is hauled at very low cost as far as Port Arthur and Fort William by grain boats which would otherwise return empty. A further difficulty on Western coal mining is that in the past governments have been too generous in leasing coal lands. Many more mines have been opened up than are needed to supply the demand. The high capital costs of these numerous mines must be borne, in the long run, by the consumer. Also there is much seasonal unemployment among the workers because the mines operate for only a short time each year even in Drumheller, the largest single producing district. Almost continuous labour difficulties are a reflection of a short-sighted policy in opening up new mines and the lack of a large industrial market. All in all, the coal reserves are of vast potential value but of moderate immediate importance.

Next to coal, petroleum[88] is the most valuable mineral of the Region. Petroleum is believed to result from the decomposition of marine organisms, including diatoms, under heat and pressure caused by the movement of the earth's crust. The resulting

[88]Francis, W., "The Petroleum Industry of Canada", *Canadian Geographical Journal*, vol. 16, February, 1938, pp. 70-89; Hume, G. S., "The Oil Situation in Alberta", *Trans. C.I.M.M.*, 1939, pp. 68-80.

petroleum will evaporate or run away unless the structure of the rocks provides a natural storage basin for it. The ideal reservoir consists of a layer of porous sandstone capped with an impervious layer of shale. If the strata are then slightly folded, the salt water which is commonly associated with petroleum will be trapped in the downfold of the rock. The petroleum, since it floats on water, will be found higher up on the fold. Natural gas, usually under great pressure, will be located at the top of the upfold.

Drilling for oil is notoriously risky. Professional geologists must examine the terrain to observe whether the underlying rocks are of such an age that they are likely originally to have contained petroleum. The folding of the strata and the nature of the adjacent rocks must be such that the petroleum be prevented from seeping away into other rocks or escaping in streams. If the geology of the area seems to give evidence of the presence of oil, a well must be drilled. This well must be carefully located with reference to the underlying strata in which the petroleum is believed to be contained. If the well strikes the oil-bearing strata too far along the downfold it will produce only salt water. If it hits the strata too far up the fold, it will yield only gas. The folds of the underlying strata do not always conform to the topography at the surface because glaciers, for example, may bury an upfold much more deeply than a downfold, and the best place to drill may be in the bottom of a surface valley or even on the top of a hill. Petroleum is sometimes found in other formations than folds. Since oil wells are very expensive to drill great care has to be exercised in deciding, first, on the general area in which petroleum is likely to be found, and then on the precise spot where a vertical hole is likely to strike crude oil, not gas or water. An elaborate science for locating wells has been developed but a very large element of luck still remains.

The most important petroleum field in the Prairie Region is

in the Turner Valley about 35 miles southwest of Calgary though there are a number of other wells at scattered points throughout Alberta. Turner Valley crude oil is of good quality and can be manufactured into gasoline and other petroleum products easily and cheaply. The output is consumed in the Prairies and eastern British Columbia. Turner Valley could supply the total Canadian demand for less than three days in the year.

Natural gas supplies a number of towns in the West with cheap and convenient fuel. The chief producing wells are in the Turner Valley, at Medicine Hat, Viking, Bow Island and Wetaskiwin in Alberta and Lloydminster on the Alberta-Saskatchewan boundary. Gypsum is mined near the northeast corner of Lake Manitoba. Salt, building clay, sand and gravel are obtained at various points throughout the Prairie Region. Sodium sulphate is secured from some of the saline lakes of southern Saskatchewan.

Fishing

Although one does not commonly associate the Prairie provinces with the fishing industry, the catch of fish from the lakes on the edge of the Shield provides a livelihood for about 6,000 men.[34] The cold northern waters of Lakes Winnipeg, Manitoba, Winnipegosis, Lesser Slave and even the Athabaska produce a fish of a firmness and flavour not found in warmer waters. Fishing is carried on mainly during the winter when whitefish are caught through the ice, frozen at once, and sent to Chicago, Montreal and New York. In summer the nearby communities are supplied with pickerel and trout as well as whitefish. The future of the industry hinges on the more extensive exploitation of the large number of northern lakes, and the provision of cheap transportation.

[34]Grant, H. C., *The Commercial Fishing Industry of Manitoba* (Winnipeg: Manitoba Economic Survey Board, 1938).

Hydro-Electric Power

In the Prairie Region proper the development of hydro-electricity is hampered by the low precipitation. Also, it is difficult to build dams across the deep trenches of the rivers so that water will not seep through the thick soil cover underneath or around the ends of the dam. For the most part the West uses steam or diesel plants or else harnesses the streams such as the Bow River at Calgary, flowing swiftly down the slopes of the Rockies, or other streams flowing out from the Shield as at Winnipeg. At the latter point the rates to domestic users are the lowest of any large city in Canada, though Toronto gives slightly more favourable rates to commercial and industrial users.[85] The low rates are due to low-cost power plants along the Winnipeg River at Great Falls and Seven Sisters Falls. The average domestic consumption is high, due to low rates and the high cost of competing fuels. Off-peak power is used in the electric boilers of a central steam-heating system which supplies heat to a number of buildings in downtown Winnipeg. A private and a publicly owned system compete with each other in Winnipeg and a private corporation supplies all Calgary's needs. Elsewhere the power plants and distributing systems are owned chiefly by municipal or provincial governments. In Manitoba and Saskatchewan provincial power commissions function on much the same basis as the commission in Ontario. In Alberta a commission regulates rates charged by private concerns.

Manufacturing

Although the value of goods manufactured in the Prairie Region has shown a steady increase over the years, manufacturing

[85]Dreiman, L. S., "Winnipeg Municipal Electric Utility", *Journal of Land and Public Utility Economics,* vol. 14, November, 1938, pp. 388-401; Fraser, J. P., "Manitoba Power Commission Transmission System", *Engineering Journal,* vol. 22, July, 1939, pp. 301-7.

is not likely to become a vital industry.[36] Most of the manufacturing is concerned with the processing of agricultural raw materials or with the production of bulky and perishable articles not readily imported from outside the Region. Meat packing, flour milling, and butter making account for 40 per cent of the total value of output. Baking, printing, and the manufacture of men's work clothing, railway rolling stock, petroleum products, beer, aerated waters, and fur goods supply most of the remainder. A wide variety of goods is produced but most of the factories are small in size. In comparison with the well-established manufacturing industry of the St. Lawrence Lowlands, western factories have a preferred position in being closer to the market both from the point of view of transportation and knowledge of its needs. On the other hand they have no advantage with respect to raw materials other than certain agricultural products. Besides, the comparatively small size of the market restricts production and raises overhead costs per unit of output. Winnipeg with its suburbs is the chief manufacturing city, due to its head start, low cost of power, larger local market and its development as a mail order centre. The large supply of cheap natural gas has aided the establishment of flour mills and clay works at Medicine Hat.

General

A review of all the economic activities of the Prairie Region shows clearly that its future is inseparably hinged to agriculture, particularly to wheat. The Bank of Canada in reporting on the financial position of one of the Prairie provinces in 1937 stated that "to a unique extent, the economic history of Saskatchewan is that of wheat. No other governmental unit in the world attempting to maintain a modern civilization and standard of living is

[36]"Growth of Manufacturing in Winnipeg", *Industrial Canada*, vol. 39, December, 1938, pp. 29-30; Kennedy, E. R., "Industrial developments and Possibilities in Saskatchewan", *Industrial Canada*, vol. 41, January, 1940, pp. 40-3.

so completely dependent on the production and marketing of one commodity—a commodity which even under normal conditions is subject to wide variations in production and price. On the average, about 85 per cent of all net production in Saskatchewan is supplied by the agricultural industry and about 80 per cent of the cash income of the agricultural industry is derived from wheat. Although some diversification has been possible in certain areas, and although there has been some increase in subsistence farming in late years, the ability of Saskatchewan to maintain its present population at any acceptable standard of living and to provide it with decent educational and medical facilities and a minimum of economic security, rests entirely on its ability to grow wheat and sell it in the markets of the world. This is true to such an overwhelming extent that wheat is . . . the salient feature in Saskatchewan's economic history . . ."[87] The same general statement could be applied to Alberta and Manitoba, with modifications, for mixed farming is much more important in these two provinces than in Saskatchewan. Throughout the West there are also secondary industries like forestry, mining, fishing, the generation of hydro-electric power and manufacturing. But since these industries sell mainly in the local market their prosperity is fundamentally dependent on the sole export industry, agriculture. The Prairie Region has, in truth, the "Wheat Economy".

[87]Bank of Canada, *Report on the Financial Position of the Province of Saskatchewan* (Ottawa: 1937).

CHAPTER V

THE CORDILLERA REGION

THE CORDILLERA REGION embraces the mountainous country of British Columbia, the Yukon, and a very narrow strip along the Rocky Mountains in Alberta. Most of the Peace River country in British Columbia must be excluded because it is topographically part of the Prairies. The Canadian Cordillera is part of the great mountain system which stretches along the western border of North America. Within Canada it has an average width of about 400 miles, a length of 1,500 and trends generally from southeast to northwest.

Topography

Despite the fact that the Cordillera Region has a greater multiformity of terrain than any other area of equal size in Canada, the general features of its topography can be stated quite simply. The Rocky Mountains and the Coast Range occupy, respectively, the east and west flanks of the Canadian Cordillera and between them is an elevated plateau deeply cut into by rivers and modified, especially in the south, by a series of mountain folds of moderate height. Each of the two mountain ranges as well as the intervening plateau has special surface characteristics.[1]

[1]Aitken, G. G., "The Progress of Survey and Settlement in British Columbia", *Geographical Review*, vol. 15, July, 1925, pp. 399-410; Andrews, G. S., "Alaska Highway Survey in British Columbia", *Geographical Journal*, vol. 50, July, 1942, pp. 5-21; Atwood, *op. cit.*, pp. 331-5, 415-23; Davis, N. F. G., "The Geology of Southern British Columbia", in Freeman, O. W., and Martin, H. H., *The Pacific Northwest* (New York: John Wiley & Sons, 1942), pp. 97-103; *The Yukon Territory* (Ottawa: Dept. of Interior, 1926); Taylor, G., "British Columbia, A Study in Topographic Control", *Geographical Review*, vol. 32, July, 1942, pp. 372-402.

The Rocky Mountains are a chain of high peaks, many with elevations of 10,000 feet or more. They rise rather abruptly from the foothills and the Prairies to the east and blend more gently into the interior plateau to the west. The Rockies are composed mainly of rocks of ancient origin and since they have been folded, under enormous pressure, from rocks which were originally flat-lying, they are distinguished by great depths of stratified formations. These can be observed in the Mount Robson district along the Canadian National and in the Kicking Horse Valley along the Canadian Pacific. At one time parts of the Rockies were covered by glaciers, a few of which still exist. Evidences of glaciers, like U-shaped valleys and hollowed out basins or cirques, are common. The Rockies have a width of about 100 miles and reach northwest from the International Boundary a distance of 850 miles, dying away as they approach the transverse valley of the Liard, with a few gentle ranges beyond.

The most important mountains north of the Liard are the little-known Mackenzies which begin 100 miles east of the Rockies. These mountains swing northwesterly in a broad crescent half-way along the Yukon-Northwest Territories boundary and thence westerly. They divide the waters which drain into the Yukon River from those flowing into the Mackenzie and its tributaries. Probably the highest peaks of the Mackenzie Mountains do not much exceed 7,000 feet.

The interior plateau of British Columbia and the Yukon has an average elevation of between 3,000 and 4,000 feet above sea level. The even topography which one normally expects in a plateau is interrupted by two factors—rivers which have eaten their way deep into the table-land, and secondary mountain ranges. The lines of communication generally lie along the river courses and so the traveller by highway or railroad may not appreciate that the interior is really a plateau. The rivers,

notably the Fraser and the Columbia, have circuitous routes and canyons in their lower reaches. Along the International Boundary there are a series of ranges divided by deep narrow valleys, some of which are occupied by lakes—Kootenay, Slocan, Arrow, and Okanagan. The most important single interior range is the Selkirks, with peaks of over 11,000 feet. The Selkirks are separated from the Rockies by a deep depression, the Rocky Mountain trench which extends from far south of the forty-ninth parallel to the Liard. In Canada the most important section commercially is that from Golden south through Windermere to near Cranbrook. This section is drained by the head-waters of the Columbia and the Kootenay. Toward the north of the interior plateau the secondary mountain ranges are less numerous than farther south and appear as flat-topped ridges separated by deep valleys.

The Coast Range of mountains is nearly 1,000 miles long and 50 to 100 miles broad. It rises abruptly from the sea to both rounded and pinnacled summits which may attain elevations of 7,000 to 11,000 feet. The Coast Range was formed by the intrusion of igneous masses into other rocks which have since been eroded. The range is crossed by a number of deep valleys such as those occupied by the Fraser, Skeena, Nass, and Stikine. Its western part is penetrated by numerous fiords which are continued inland by deep U-shaped valleys. Along the Pacific coast of Canada and the Panhandle of Alaska are many small islands, which are the survivors of mountains which in common with the coast generally have partly sunk beneath the sea. Relatively low but rugged mountains are also exposed farther offshore as Vancouver and the Queen Charlotte Islands.

Geology

The very early geological history[2] of the Cordillera Region

[2]Atwood, *supra.*; Young, *op. cit.*, pp. 142-87.

is obscure because the Precambrian rocks have been very much metamorphosed by subsequent structural movements. The most significant feature of the Mesozoic era was the intrusion of masses of molten material into the mountains of the Coast Range. So extensive was this intrusion or batholith that the granite rocks formed from the slow cooling of the mass now occupy a continuous area 1,000 miles long and in places 100 miles wide. Long-continued erosion reduced the Coast Range so as to expose their coarse granite cores at the surface of the earth.

The close of the Mesozoic, that is, the beginning of Cenozoic time, was marked by widespread structural movements known as the Laramide Revolution. Actually the orogenic movements which characterized the "Revolution" took place slowly, though there may have been sudden jerks causing earthquakes. In any case strata were uplifted to great heights, and gently folded and faulted. Great blocks of rock were thrust eastward over the underlying strata. The great Rocky Mountains were created in this era.

While the Rockies were being brought into being, the plateau and the mountains to the west were also being uplifted as a whole. The parallel ranges of mountains in the interior were upraised but downfolding created the Rocky Mountain trench and the subsidence of the valley west of the Coast Range formed a trough along the coast into which the sea entered. Some of the highlands to the west of the trough remained above the surface of the water and now appear in Vancouver Island and the Queen Charlottes, and in the numerous islands immediately off the coast of British Columbia and the Alaska Panhandle. These orogenic movements took place without markedly distorting the strata. The bands of rocks were gently folded—not greatly broken, faulted, nor thrust over one another.

During the Laramide Revolution when the Region as a whole was slowly uplifted, the existing rivers were given a steeper

gradient and greater velocity than before. They were able to erode more vigorously but because uplift took place at about the same rate as the rivers wore down their beds, they had only sufficient erosive power to dig deep channels or canyons in their courses and could not carry down enough material to create the gentle slopes which characterize old or mature river valleys. The uplift did not occur uniformly over the entire Region and so the streams were sometimes prevented from running in their original courses and had to seek new channels as well as wear down the old. For these reasons the present rivers, notably the Fraser and the Columbia, are marked by canyons and circuitous routes.

In the late Cenozoic a great thick body of ice covered most of the Cordillera as it did the Prairies and Eastern Canada. Since the Cordillera was bounded by mountains on the west and east, the movement of ice had rather different results from elsewhere in Canada. A mountain or alpine glacier typically moves down the valley of a pre-existing river, whereas a broad ice-sheet or continental glacier pushes out over an extensive area. An alpine glacier advances along several rather narrow fronts instead of more or less regularly over a broad one. It widens the river valley along which it moves and cuts off some of the projecting headlands. It rasps down the rocks immediately in its path and freezes solidly around pieces of rock projecting from the banks of the stream—sometimes back for a considerable distance from the actual bed of the former river of water. As this river of ice moves slowly along, it pulls or plucks the projecting rocks from their bases. After the glacier melts, the channel in which it has moved will be comparatively straight or gently winding and be U-shaped, with relatively steep sides.

The alpine glacier will also pluck the rock from the basin in which it originates. In this way it forms a bowl or cirque. Sometimes, in subsequent periods of time, the cirque is partly

filled with water as at Lake Louise. Larger glaciers have much more erosive power than their smaller tributaries and hence they create deeper channels. After the retreat of the glacier, the smaller valley is left far above the larger—a hanging valley, it is called. If a river should flow along the tributary glacial valley it will fall into the main valley by a high cascade. There are several examples of this in the Canadian Rockies. Sometimes the main valley is dammed by the moraine which the glacier, as it melts, drops across its floor. Eventually the valley above the dam will become partly filled with water, to form "finger lakes" like Arrow and Kootenay.

Along the coastal range the Pleistocene glaciers came down to the sea. Ice will not float in salt water until about nine-tenths of its volume has been submerged. Thus a glacier 1,000 feet thick will theoretically erode a channel 900 feet below sea level before it breaks off and floats away. After the glacier retreats, it leaves behind a deep, winding, steep-walled channel or fiord, extending for several miles out to sea. The same topographical formation is found inland from the head of the fiord, often with hanging valleys and waterfalls. Fiords are common along the west coast of the mainland and Vancouver Island.

While the glaciers were still slowly retreating, the streams took up again their work of erosion. Some of the glacial lakes, especially Okanagan, were nearly filled with detritus. The level of the lake at this time was considerably higher than it is now but the obstructions in the channel of the Columbia which drains it were removed probably by erosion, possibly by the local down-sinking of the land. At all events, the lake was partly drained and some of the detritus carried away, while the remainder was left as benches or natural terraces above the present lake level.

Retreat of the glacier was accompanied by the dropping of moraine, usually along the floors of the valleys. In the vicinity of Vancouver and on parts of Vancouver Island the glacial

material was later re-worked by running water.[3] On the whole, glacial deposition was very much less important in the Cordillera Region than in other parts of Canada, mainly because the presence of high mountains confined the work of the ice to valleys and cirques.

The significance of this geological history is obvious. The intrusions of igneous rocks from which great depths of overlying rocks have been eroded, are heavily mineralized with gold, silver, copper, lead, zinc and some iron. The coal-bearing strata are important. The terraces of the interior lakes, the glacially deposited soils of the mainland and Vancouver Island, and the broad but dissected plateau of the interior are significant from an agricultural standpoint. The cirques, glaciated valleys and finger lakes along with the hanging valleys and waterfalls are fine tourist attractions in the Rockies. The fiords of the coast, a few of them with small glaciers at their head, also lure tourists. This is especially the case because the sunken trough between the islands and the mainland allows steamships to sail along the shore while being fully protected by the islands from the storms of the Pacific.

Climate

The climate of the Cordillera Region is difficult to describe accurately without going into burdensome detail.[4] The great differences in elevation and the range of latitude covered make for wide variations in the climate between adjacent districts. Generally, the climate is more equable than in other parts of Canada. This is due to the moderating influences of the prevailing winds which, blowing from across a broad ocean, make

[3]Laird, D. G., and Kelley, C. C., "Soil Surveys; a Basis for Land Utilization in British Columbia", *Scientific Agriculture*, vol. 15, January, 1935, pp. 259-67.

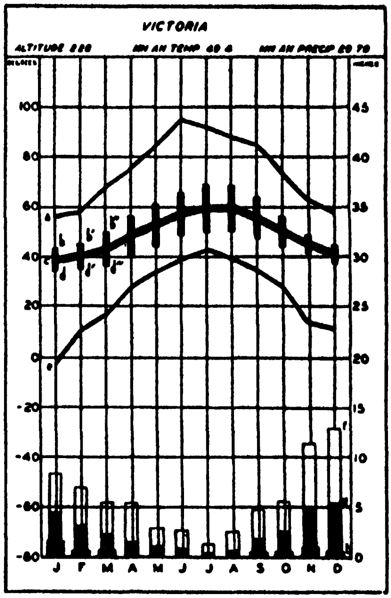
[4]Church, P. E., "Climates of the Pacific Northwest" in Freeman and Martin, *op. cit.*, pp. 104-25; Kendrew, W. G., *Climate* (Oxford: The Clarendon Press, 1938), pp. 313-6; Koeppe, *op. cit.*, pp. 68-98.

the winters milder and the summers cooler than they would otherwise be.

The climate, called by meteorologists Marine Cyclonic, is the same broad type which exists in the British Isles, Germany, the Low Countries, most of France and, broadly speaking, the most progressive parts of Europe. In Europe marine influences penetrate far inland, for there are no high or broad mountains along the coast and other mountain ranges, like the Alps and the Carpathians, trend parallel to the wind. Eventually the effect of the ocean is counteracted by the heating up and cooling off of the land mass in the interior of the continent in summer and winter respectively. In Canada, on the other hand, the Marine Cyclonic region is small. The oceanic influences are confined to districts near the coast by mountains which are high, broad, and commonly run at right angles to the wind. As one goes into the interior of the Region the mountains weaken the marine influences and finally in the plains the marine influence is destroyed entirely. The topography along the Pacific coast is a serious limitation on the agricultural development of Canada, however much it may have helped mining and water-power.

Marine cyclonic influences are strongest in Vancouver Island and adjacent parts of the mainland. At Vancouver the annual range of temperature is typically between 20 and 85 degrees, though both lower and higher temperatures have occasionally been experienced. In Victoria the winters are as mild as those of Richmond, Virginia, whereas the summers resemble the winters in St. Petersburg, Florida, as far as temperatures are concerned. The frost-free period is about seven and a half months in length. The rainfall of 30 inches comes mainly in the late fall and early winter when the contrast in temperatures between land and water are greatest and when the warm winds from the Pacific, being cooled by contact with the land, give up their moisture. In summer the contrast is not so great and the cyclonic

storms which create precipitation are weak. Along the west coast of Vancouver Island precipitation is much greater than at Victoria—200 inches or more—because as the moisture-bearing winds from the Pacific rise up the mountain slopes they expand, become cool and drop their moisture. Rainfall at Vancouver is nearly twice that at Victoria because the winds in their journey



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across the Straits of Georgia pick up additional moisture. Toward the north of the littoral, in Prince Rupert, for example, rainfall is greater and more persistent and the temperatures generally are lower than farther south.

In the interior plateau or dry belt, the rainfall is very much less than on the coast. At Clinton the average annual rainfall

is 5.86 inches; in the Kamloops district it is 8 to 10 inches. The reason for this arid condition is that the mountains have already absorbed or "wrung out" the moisture from the Pacific winds and the warm southerly air masses of cyclonic storms find it difficult on account of the mountain barrier to bring in moisture from the Gulf of Mexico as they do to the Prairies. There is some tendency for the western slopes of the interior mountain ranges to receive more precipitation than the eastern ones because the latter are more in the "rain shadow" of the mountains. In the interior the range of temperature throughout the year is considerable. Temperatures below zero in winter and over 90 degrees in summer are not unusual. The continental influences become more pronounced as one goes farther north. At Dawson the average temperature during the three warmest months is 57 degrees. In the winter months one day in three is 40 degrees below zero or lower. In January the temperature is rarely above zero. In the higher altitudes of the mountains temperatures are persistently lower than on the lower slopes. It is necessary to reiterate that there is wide variation in temperature and rainfall from one locality to another due to differences of elevation, exposure to the sun and to prevailing winds, latitude and so on.

Agriculture

The agriculture of the Cordillera Region falls into four districts; the irrigated lands of the southern interior; the grass lands of the central section of the interior plateau; the dairying and mixed farming of the lower mainland and Vancouver Island; and the pioneer farming of the northern and coastal forested districts.

Of the irrigated lands in the south[6] the most important are in

[6]British Columbia, *Manual of Information* (Victoria: 1930); Britton, J. E., Fisher, D. U., and Palmer, R. C., *Apple Harvesting and Storage in British Columbia* (Dom. Agric. Dept., 1941); Freeman, O. W., "Apple Industry of the Wenatchee Area", *Economic Geography*, vol. 10, April, 1934, pp. 160-71; Freeman and Martin, *op. cit., passim*; Grunsky, H. W., *Report*

(Continued on next page)

the valley partly occupied by Okanagan Lake, the district from Vernon southward through Kelowna and Penticton to Oliver and Osoyoos. The chief products are fruits,—apples, peaches, cherries, and apricots—along with vegetables of all kinds. The average annual precipitation in the Okanagan is less than 15 inches and irrigation is necessary for almost all cultivated crops. Snow is never heavy near the lake but there is a good deal nearly every year at higher altitudes in the south and even at low levels in the north. Snow adds to the moisture content of the soil but if the fall of snow is too heavy it tends to break down the limbs of weakly wooded trees like peaches. Because of the southerly location of the Okanagan, the comparative absence of rain, and the complete absence of fog, the amount of sunshine is high. This is important in keeping down certain fungi and particularly in producing fruits with brightly coloured skins. The frost-free season averages 200 days. Winds blowing down the valley itself or down ravines in the mountains assist in frost drainage but too strong winds may bruise soft fruits like peaches and cherries and even break the limbs. Because these winds are more prevalent toward the north, the Vernon district concentrates on apples, while soft fruits are more common farther south. Another factor discouraging the growth of tender fruits around Vernon is that, although the seasonal averages of the north and south Okanagan are about the same, lower absolute minima temperatures are experienced during the winter in the north than toward the south. Short spells of very cold weather during the dormant season are harder on trees producing fruit with stones than they are on

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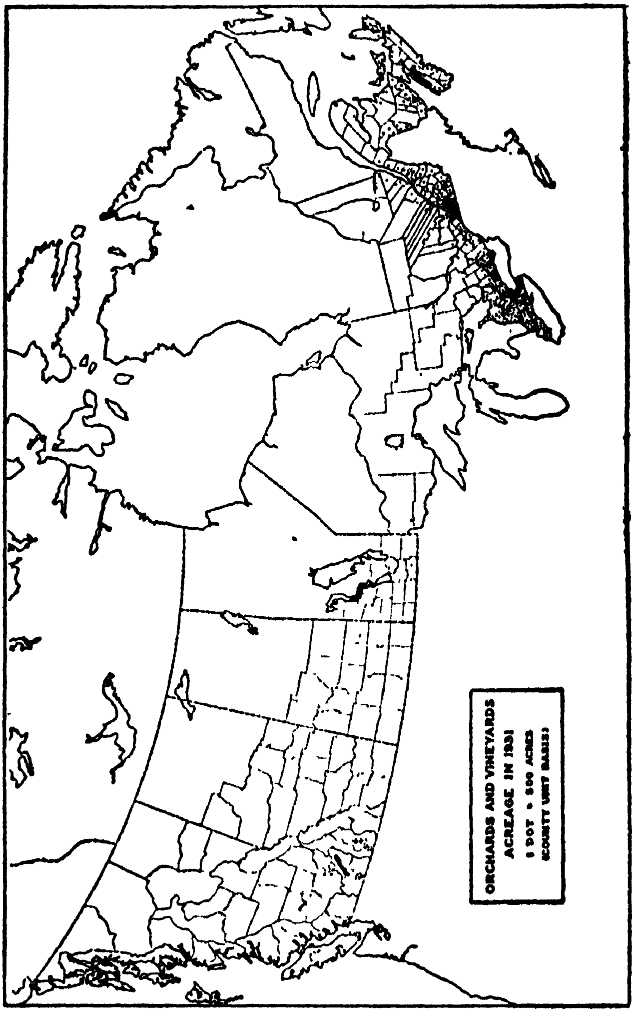
on a Public Irrigation Corporation Bill, Victoria, 1914; Ormsby, M., *A History of the Okanagan,* unpublished thesis, University of British Columbia; Royal Commission Investigating the Fruit Industry, *Report* (Victoria: 1929); Special Commission Investigating Irrigation Companies, *Report* (Victoria: 1918); Swan, W. G., *Report on the Economic Conditions in Certain Irrigation Districts* (Victoria: Dept. of Lands, 1928); Winslow, R. M., *Information for Fruit Growers* (Victoria: Dept. of Lands, 1913).



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trees the fruit of which has cores. The greater prevalence of the codling moth in the orchards of the south may also be a partial explanation of the specialization within the valley.

The topography of the district aids horticulture. The lake waters retain a good deal of heat in the fall after the land has cooled and so they tend to postpone frosts and moderate winter temperatures. As in the Niagara district the influence of the water is overdone near the lakes and hence the orchards are located on the bench lands higher up. Steep slopes are not suitable orchard sites because they cannot be cheaply irrigated, but the benches which are level or very gently sloping can be easily supplied with adequate amounts of water by streams flowing down flumes from the mountains. Some of the soils were formed from volcanic ash and hold water (form clods) to an exceptional degree when wet. They tend to make a high proportion of the precipitation available for plant growth. In places the soils are clay loam and gravel which warm up quickly in the spring. Generally speaking, the limitations on the growth of fruit in the Okanagan are lack of water and suitable markets. Much more land is available for the growth of fruits than can be irrigated and the marketing problem even with the present area is often acute.

The problems of irrigation in the Okanagan can be dealt with most clearly by considering the history of the district. Originally all the land was devoted to grazing and cattle were driven long distances to markets in railway construction and mining camps. When railways entered the Okanagan itself, agricultural production shifted to wheat which was climatically suited to this dry district. Gradually, beginning as early as 1874, settlers brought water by simple wooden flumes from ponds behind beaver dams in the hills down to the benches. Apple growing was started and quickly expanded in the early 1900's when a ready market was opened up in the rapidly expanding Prairies

which were climatically incapable of raising apples. The prospects of profits induced increasing numbers of fruit growers into the district but they usually found that the easily accessible sources of water had already been pre-empted by the first-comers. Long and acrimonious disputes over water rights ensued.

Meanwhile, companies had purchased large areas of land. In order to add to its value the companies began to construct elaborate irrigation works. These were expensive despite the low cost of local lumber. Generally speaking, these works could not be built piece-meal; a relatively large enterprise capable of supplying water to an extensive acreage had to be constructed at one time. Because of this, large blocks of land had to be settled in a short period of time, otherwise heavy expenses would have been incurred for a few farmers. In order to speed up settlement the land companies induced a number of retired army officers to come in, holding out the delightful climate and the pleasant occupation of horticulture as inducements. Unfortunately these settlers had no knowledge of fruit growing on a commercial scale. Even orchardists from the Niagara Peninsula who came in small numbers were handicapped in handling irrigated lands. Only after many years was a fund of knowledge regarding irrigation horticulture acquired and the district was able to make steady progress.

To the difficulty of acquiring knowledge of fruit growing by trial-and-error methods, there were added problems of engineering and economics. Builders of many of the early irrigation works did not carefully study such important factors as the flow of water in the streams, the type of terrain which could be irrigated cheaply, and of orchard sites which would avoid excessive cold and high winds. Also, the companies made their initial profits out of selling land and naturally they sold as much as they could. Usually they sold more land alleged to be irrigable than they could supply water to. An orchard, as it matures, requires

more water than it does in its early stages. Farmers who had planted orchards could not get enough water for them. Some of the orchards gave low yields and others which were poorly located had to be abandoned entirely. In a few cases—and usually more by good luck than good management—there was adequate water, but then the irrigation companies kept the rates up to the highest possible level. All the profits went to the irrigation companies and farmers protested bitterly. Some of these farmers abandoned their irrigated fields entirely, leaving the full cost of the irrigation works to be borne by the few farmers who had continued to irrigate. Some farmers only used water in exceptionally dry years. The companies themselves lost money as the sales of water fell off. Although they had made good profits by selling land, they now made little if anything by selling water. They neglected to maintain their dams and flumes which, being chiefly of wood, soon decayed. Meanwhile, a few farmers who had secured private access to watercourses in the early period of settlement were doing fairly well financially but their neighbours were disgruntled because of the "unearned increment" of the lucky. The whole matter of irrigation developed into a series of tangles and the provincial government was called upon to act as umpire on several occasions.

The problem of the control and supply of irrigation water was solved by moving in two directions. A careful study was made of the engineering problems such as the total flow, its variability from year to year, the building of flumes with the proper gradients and of dams with good foundations, the equitable distribution of water among the farmers under the same project, the restriction of the irrigable area to a size no larger than could be adequately supplied with water in the year of the poorest rainfall, and so forth. On the economic side most of the commercial irrigation companies have been taken over by the municipalities in the Okanagan. Many of them are not financially profitable

since the cost of maintaining them and of paying interest on their original cost is higher than the farmer can afford to pay. Raising the price of water is no solution since the farmer may refuse to buy water at all, letting his land revert to grazing. This merely makes the financial position of the project worse than before.

The provincial government in British Columbia, like that in Alberta, has had to come to the aid of farmers on irrigated land. In particular, in 1920 it began to finance a project around Oliver as an outlet for returned soldiers. This district is lower in altitude than Okanagan Lake and ample supplies of water can be delivered cheaply to it. The Oliver area grows tender articles like canteloupe and apricots because its climate is slightly more favourable than the districts farther north. There is a large market for these products because they cannot be grown satisfactorily anywhere else west of the Great Lakes. Canteloupes give a quick return, whereas there is a long wait for any net income from tree fruits. Growers in other districts in the Okanagan regard provincial aid to the Oliver project as essentially unfair.

In brief, the engineering and economic problems in connection with the supply of irrigation water are complex and are only gradually being solved. There is still plenty of land which could be irrigated if water were available. All the water at present being used is supplied by streams flowing into Okanagan Lake from the hills and mountains round about. Many schemes have been tried for elevating the water from the lake itself to the benches 200 or 300 feet above. None of these has been successful, though if the local hydro-electric power company were prepared to grant low enough rates there is no physical reason why much more land could not be irrigated. The supply of irrigation water in this area is a complicated illustration of the overlapping of economic and geographic factors.

Once water is provided a farmer must wait from 6 to 10 or

15 years before his orchard produces a large enough crop to cover the cost of production in any one year. Meanwhile he has had to pay for irrigation water, prune and spray his trees annually, fertilize the soil, and generally pay out a good deal of money with practically no income. Some farmers will be forced to abandon their land because they have not sufficient funds to maintain themselves until they can get a return from their orchard. Shrewd individuals coming into the area after, say, five years will buy up such land, hold it for a relatively short period of time until the orchard actually comes into production, and then reap a reward which is largely due to the inability of the original farmer to hang onto the land. Also, since a considerable area was settled at about the same time, a large number of trees come into production in the same year. Unless an increase in demand coincides with the increase in output, prices will fall. This further postpones the day when the farmer secures a reasonable return on his year's operations, let alone compensation for expenses incurred while he developed his orchard.

Despite these difficulties the Okanagan Valley has attained a very real prosperity. This is largely due to the fact that it produces articles on which there is very little competition from nearby non-irrigated lands. The Prairies cannot grow fruit on a commercial scale at all though there have been some promising experiments with hardier fruits like crab-apples. Generally speaking, the same thing applies to heat-loving vegetables like canteloupes, tomatoes, cucumbers and asparagus but not to onions, potatoes, lettuce, carrots and peas. In time the inter-mountain grower may face competition between his products and those grown locally in the West but he may avoid this by raising superior quality articles for canning.[6] Most fruit farms are small,

[6]Richards, A. E., "Observations on the Economic Problems of Growing Fresh Vegetables in British Columbia", *Economic Annalist*, vol. 4, December, 1934, pp. 55-8.

15 to 20 acres, almost all in orchard. The farmer gives all his attention to horticulture and rarely keeps a cow or even a horse. He usually lives in a nearby village rather than on the farm itself.

The most difficult problem faced by the industry is that of markets. Peaches, cherries, and even apples are highly perishable articles and their distribution should be so arranged that there is neither a dearth nor a glut of fruit on a particular market at any one time. The necessity of preventing either one of these contingencies favours the creation of a central sales office, or a single selling agency. Such an organization can assist the growers by grading so that only the better-quality fruit goes to market and a higher price can thus ordinarily be secured than if various qualities are mixed together indiscriminately. Moreover, it can attractively package the apples in boxes, advertise them in magazines and generally expand their sale. Under competitive conditions no one firm is willing to advertise. There is little or nothing to distinguish the apples of one group of growers from those of others. If one grower advertises, competitors quickly come in, sell their articles instead of those of the advertiser and thus "steal the advertising". A single selling agency can also make arrangements to dispose of low-quality fruit by canning the whole product or its juice. It may sell goods at high prices in those districts which are prepared to pay high prices and sell at low prices in places where the people are not willing or able to pay more. By the use of this two-price policy it may be able to increase the return to the grower above what he would have received had the goods been sold at a uniform price, quality considered, to all purchasers.

At all events, many of the growers favour a single selling agency. At one time a privately-owned company of fruit distributors was able to get most of the sale in their hands but the

company was outlawed on the ground that it was using its semi-monopolistic power to make large profits for itself without passing on any of the alleged benefits either to growers by paying more or to consumers by charging less for the apples. The growers have now formed their own co-operative organization. The independent distributors have continued to function and usually work with the growers' co-operative. The hands of the central agency have been strengthened from time to time by legislation the effectiveness of which has been rather spasmodic. In general terms, the growers have been trying to capitalize on their semi-monopolistic position in respect to the market for fruit in Western Canada. The partial monopoly arose from geographic conditions and the existence of a tariff on American grown fruit for most of the year. The Okanagan fruit growers, like all other economic groups in the country, are anxious to get a reasonable return for their work.

At Grand Forks the Kettle River, a tributary of the Columbia, flows over the flat floor of a wide valley. Apples, potatoes and onions are grown for sale and other crops raised for local use. The irrigation system which was once in operation is not now being used. It is more profitable to use the natural rainfall instead of irrigation water which, though it augmented yields, also increased costs. At Ashcroft on the North Thompson River the presence of a series of terraces behind which are small reservoirs higher up in the hills makes it possible to lead the water cheaply through pipes to fertile soil where fine potatoes are grown. There are other irrigation projects like those at Salmon Arm, and along the Arrow River and the Kootenay and Shuswap Lakes but all of these are relatively small. From the standpoint of the geographer each scheme is a means of offsetting the lack of rainfall by taking advantage of minor topographic conditions in the particular locality.

Problems connected with water in the dry belt are not con-

fined to irrigation. Near Creston[7] the Kootenay River after crossing the International Boundary formerly meandered back and forth over a flat delta from one to four miles wide before entering Kootenay Lake to the north. At times of high water the delta was completely flooded and farming was confined to the higher bench lands nearby. In the 1890's a proposal was made to lower the level of the lake by blasting a deeper outlet near Nelson, where the Kootenay River flows out from the west arm of Kootenay Lake to join the Columbia at Castlegar near Trail. In addition a canal was to be built at Canal Flats in the Rocky Mountain trench north of Cranbrook to divert the waters from 1,825 square miles at the head of the Kootenay River into the Columbia. At Canal Flats these two rivers are only a mile apart but they flow in opposite directions and due to the uneven uplift of the land, they are nearly 400 miles apart before they again begin to flow toward each other to join at Castlegar. By diverting head-waters and blasting a lower outlet, the delta at Creston would be made available for field crops. The scheme had to be abandoned because the increase in the volume of water in the upper Columbia would mean the flooding and consequent relocation of the railway lines along its course.

When the scheme was revived in the 1920's a further difficulty arose. Any diversion of water would lower the level of Kootenay Lake and reduce the amount of hydro-electric power being developed near Nelson for use in the important metallurgical works at Trail. The problem was solved, not by diversion and blasting, but by erecting dykes along the Kootenay in the delta. These dykes hold back flood waters which may rise as high as 24 feet above the low water mark at Creston. The cost of dyking is about $50 an acre but there is no timber on the delta lands, whereas the cost of clearing timber from the bench lands nearby is about $150 an acre. Since the land lies in the valley bottom

[7]International Joint Commission, *The Kootenay Valley* (Ottawa: 1935).

where there is no chance of frost drainage, fruit growing is impossible on the reclaimed land. Most of the 30,000 acres of dyked lands are used for raising high-quality wheat which yields 75 bushels to the acre compared with an average of 15 on the Prairies. It is strange to see grain elevators rising literally in the heart of the mountains. Since the natural rainfall is adequate for wheat, drainage rather than irrigation is the basic problem at Creston.

The second district of agricultural importance is the dry lands of the interior plateau. This area stretches from the edge of the forested area just north of the Prince Rupert-Jasper line of the Canadian National southward to the International Boundary. It comprises all the interior plateau except the northern or forested half. The district overlaps the fruit regions of the Okanagan and other interior valleys. In an area as large as this the climatic conditions naturally vary a good deal.[8] This is due not merely to the range of latitude covered but also to the fact that on a plateau slight differences in elevation frequently have marked effects on temperature and rainfall. The precipitation ranges in different parts of the district from 5 to 18 inches annually with a general average of about 10. Snowfall is fairly heavy in the north but light in the south. The summers are warm and sunny. In places the configuration of the land may be such as to give temperatures of over 100 degrees for short periods of time. The winters are quite cold but sunny. The frost-free period averages 190 days in the Nicola Valley and the Rocky Mountain trench toward the south but no more than 130 in the north.

In view of the climate and the generally rough terrain in the

[8]Information for Fruit Growers, *op. cit.*, *passim*; British Columbia, Department of Lands, *Bulletins (Land Series)* (Victoria: 1919-20), *passim*.

area, ranching is the chief occupation.[9] An interesting reflection on historical development in British Columbia is that all farmsteads whether specializing in fruit, poultry, sheep, beef or dairy cattle are called "ranches". Ranching in its proper sense refers to that type of agriculture where animals, usually beef cattle or sheep, are raised under the natural grass conditions, with little or no feeding in stables with grain and cultivated grasses.

So defined, ranching extends throughout the plateau, locally known as the Cariboo. It is also conducted in the interior valleys of the south especially in the Rocky Mountain trench and on the periphery of the fruit districts. Around Vernon a few farms combine fruit growing, dairying and ranching but usually these enterprises are separated from each other as far as the individual farmer is concerned. Of two farmers adjacent to each other, one may carry on horticulture and the other ranching, depending on their personal inclinations and the suitability of their land for irrigation. Rarely are the two types of agriculture combined on the same farm, for the work of caring for an orchard and irrigation ditches leaves little time or money for other enterprises.

The general practice both in the Cariboo and in the interior valleys is to pasture the cattle on the lower, more open ranges in the spring and late fall. Then for about four and a half months during the summer the herds are driven to the higher, timbered lands where grass grows in patches. About 6 2/3 acres of open range and 10 acres of timbered land are needed for each mature beast. In the past the lack of sufficient winter feed has forced ranchers to turn their cattle out on the range as early as possible in the spring and bring them in late in the fall. Crowding too many cattle on the spring and fall grazing grounds has led to the evils of over-grazing—impoverishment of the soil, destruction of

[9]B.C. Dept. of Agric., *Report* (Victoria), annual, *passim*; B.C. Dept. of Lands (Forest Branch), *Report* (Victoria), annual, *passim*; Chapline, W. R., and Cooperrider, C. K., "Climate and Grazing", *U.S. Yearbook of Agriculture, 1941*, pp. 459-76.

valuable forage plants, prevalence of unpalatable weeds and sagebrush, and ultimately a poorer grade of stock raised at greater cost. In order to restore the pasture, crested wheat grass is sometimes planted, but the cheapest method of rehabilitation is to give the pasture ample rest in the winter and early spring and then keep down the number of animals pastured on a given area. It is important also to see that the cattle graze all parts of the range, for left to themselves they eat the grass only from the more accessible parts. They can be encouraged to graze the entire range by distributing salt in different spots and by clearing trails to isolated pastures and drinking places.

At one time most of the mature cattle raised in the interior were sold in the fall when the range began to dry up with the approach of winter. These cattle lacked the good finish and tender meat which stall-fed cattle possess. Since large numbers were thrown on the market in a short time in the fall, prices were often depressed then. Recently efforts have been made to improve quality and to market in more orderly fashion by feeding the cattle on alfalfa grown on irrigated lands in the vicinity. The irrigation systems are not elaborate affairs like those in fruit-growing districts but are created simply and cheaply by damming up mountain streams and distributing the water in trenches over the ground. The ranchman who possesses a few acres of land that can be irrigated in this way has a great advantage over his less fortunate neighbour. There are several thousand acres, especially along the Pacific Great Eastern Railway, which are physically capable of irrigation[10] but the expensive engineering works required will not likely be built, at least not for many years to come. The lands when irrigated would be too cold for fruit and if they were to raise only feed for cattle they would have to

[10] Dennis, J. S., *Report on the Examination of Natural Resources Tributary to the Line of the Pacific Great Eastern Railway* (Victoria: Dept. of Lands, 1922).

face the competition of livestock raised more cheaply on non-irrigated land.

In addition to cattle, this ranching area raises sheep though the two animals cannot be raised on the same land. Sheep-men are often forced out of business on account of the depredations of the coyote and bear. This is especially true of the smaller ranchers who cannot afford either to hire a shepherd to guard their flocks or build fences to keep out wild enemies. Both sheep and cattle ranching must be undertaken on a large scale if they are to be profitably carried on at all. One incorporated company has 500,000 acres of land under ownership or lease and annually sells about 14,000 head of cattle. The small rancher has high costs of operation because the expenses of herding must be spread over a small number of head and thus the cost per head is high, whereas one herder can look after a larger number of animals without any increase in total expense and with a reduction in expense per head. The small rancher, too, often finds it difficult to get the proper balance of pasture. He must have the right number of acres of open range to go with a certain number of acres of timbered land otherwise he has too many cattle or sheep at one time of the year or too few at another. In either case his income is reduced. He is particularly handicapped if he has no land suitable for irrigation.

The third important agricultural district in British Columbia is the mixed-farming areas in the lower Fraser Valley and the Lower Island.[11] The lower valley is an isosceles triangle with its base about 60 miles in length, stretching from Agassiz to Vancouver and sides with lengths of 50 miles reaching an apex at Bellingham on the coast just south of the International Boundary. This district has a total area of about 1,500 square miles. Part

[11]Clement, F. M., *Milk Inquiry Commission, Report,* Victoria, 1928; English, S., "Problems of a Specialized Area", in Innis, H. A. *ed., The Dairy Industry of Canada* (Toronto: The Ryerson Press, 1937), pp. 213-48; Taylor, *supra.*

of the valley is occupied by the Fraser delta, which is being extended seaward at the rate of about 5 feet a year because the Fraser is continually carrying down sand and gravel from its upper reaches and depositing them in the Gulf of Georgia. In parts of the delta the deposits are over 1,000 feet deep. The soils of the lower Valley have been modified by glacial action so that the district is now spotted with peat bogs, swamp, glacial till and gravelly ridges as well as with good clay and loam. Along the lower Fraser dykes have had to be erected to protect the land against inundation by the high spring floods which are caused by snows melting in the mountains at the same time as there may be heavy rains along the coast.

As a farming region the Valley is fortunate in its climate. The winters are mild, short and rainy. Spring arrives early, in late February or March. The summers have low rainfalls but the temperature is rarely over 80 degrees and the pastures do not dry up to the same extent as they do, for instance, in Western Ontario. Another advantage is easy access to about one-half the population of British Columbia, in Greater Vancouver and New Westminster. The chief drawbacks are that many of the soils are of poor or mediocre quality and the cost of dyking, draining and clearing the land is high. Most of the land which it pays to cultivate under present prices has already been occupied.

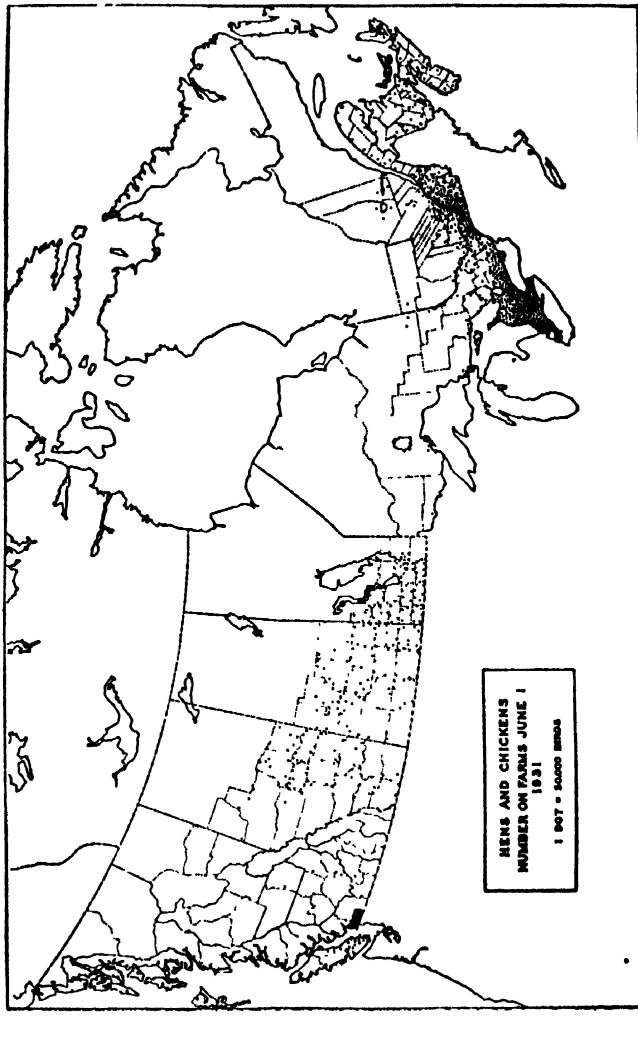
In view of its advantages with respect to climate and markets it is natural that the lower Valley should concentrate on the production of dairy products. Because of the small area of good land in comparison with the nearby market, most of the milk is sold raw, as whole milk or cream for domestic use. Most butter and cheese sold in Vancouver is brought in from the Prairies. These are comparatively distant areas which are under the necessity of concentrating milk and rendering it less perishable before sale. The Fraser Valley can sell most of its milk in a fresh condition but any surplus is disposed of, partly in the form

of butter, mainly as canned milk which is cheaply exported through the port of Vancouver to India and other countries with an inadequate milk supply. Incidentally the canneries are located at Ladner, Chilliwack and Abbotsford, places just beyond the limits within which fresh milk can be cheaply hauled to the cities.

Another specialty product of the Valley is poultry. Before hens were domesticated they laid eggs only in the spring for then the temperature and humidity conditions are such that chickens hatched from the eggs had the best chance of survival. Mankind is not content to enjoy eggs only at one season of the year and so through the course of centuries he has bred hens which will lay eggs all the year round. Even so, egg production normally reaches a peak in the late spring and declines in the hot summer, in the cold dark days of winter and, for reasons not yet entirely clear, in dry weather at any time of year. The lower mainland of British Columbia is free from both dry hot summers and cold dry winters. It has been demonstrated by experience and experiments that egg production per hen is higher and the eggs are of better quality in this district than in any other part of Canada.

Natural advantages have been supplemented by careful attention to breeds and the efficiency with which the hen uses her feed, by the elimination of birds which do not produce enough eggs to pay for the feed which they eat, and by supervising the hatching of chickens and the health of the growing and mature birds.[12] With the exception of a few flocks outside the larger cities in the East, this is the only part of Canada where poultry is raised on a specialty basis. Elsewhere the flocks are looked after by the farmer's wife or children in their spare time and are

[12] *Report*, annual (British Columbia: Dept. of Agric.), *passim*; Dominion Committee on Market Poultry, *Improved Market Type in Poultry Breeding Stock* (Dom. Dept. Agric., 1935).



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fed the waste grain or the scraps from the table, but here the farmer himself carefully tends the fowl and pays particular attention to their diet. Specialized poultry farms are rarely more than 15 acres in size with one or two cows, several fruit trees, a few acres of crops and several hundred hens.

Poultry in the valley are fed almost entirely on grain brought in from the Prairies. When the Western crop is high-priced, the Fraser poultry industry suffers. Even with low or normal prices the industry is limited by the high cost of bringing in the grain. At the same time the shipment of eggs and poultry for consumption in the Prairies and Eastern Canada is restricted by the cost of freight eastward and by the expense of refrigeration which is necessary if the eggs are to arrive in fresh condition. Fraser Valley producers are encouraged to raise as many eggs as possible in the early fall and winter because egg prices are highest when production in Eastern Canada is at its lowest. The output of poultry for meat is less important than the output of eggs. Where feed is relatively expensive it is more profitable to raise eggs than meat, while on the Prairies where feed is cheap the reverse is true.

The lower Fraser Valley is the only part of Canada where hops are raised. These are grown from cuttings or seeds. The vines are allowed to run over low wooden trellises. In the early fall the green fruit, technically known as a cone or strobile, is picked by hand, dried in well-ventilated barns and sheds heated with charcoal fires, bleached with sulphur fumes and then sent to Eastern Canada for use in the brewing industry. The number of acres devoted to the crop is quite small. The chief limitation on the extension of the industry is the lack of ample supplies of cheap labour willing to undertake the laborious job of picking the fruit.

A small amount of tobacco is grown in the Valley, especially

around Sumas.[18] Near that town a lake has been drained by pumping its waters into a tributary of the Fraser. The size of the lake has been reduced and the old lake bed partially exposed. On its generally fertile soil crops of vegetables, berries and hay in addition to tobacco are grown. Attempts to grow tobacco in the Okanagan and around Creston have not, generally speaking, been successful, mainly because of lack of knowledge and experience in caring for and curing the crop.

The amount of grain produced in this district is small because the limited amount of land can be more profitably used for other crops. Pasture is important both on the poorer soils and the better land. As in other parts of British Columbia, the number of hogs is relatively small. It is cheaper to import grain which has already been concentrated into meat than it is to bring in the bulky grain and feed it to animals near the market. Nevertheless, there are two small packing plants in the Lower Mainland to handle the comparatively small number of hogs, beef cattle and older cows which are raised as by-products of the dairy industry.

The Lower Island district includes the Saanich Peninsula and the islands of the Gulf of Georgia such as Galiano, Gabriola and Salt Spring. The district also incorporates a few smaller patches of fertile land near Victoria and at other points along the eastern side of Vancouver Island as far north as a fairly extensive area of deltaic origin near Courtenay. These districts enjoy substantially the same climate as the Lower Mainland except that the rainfall is much less. As they are also close to good markets they raise practically the same products as the Fraser delta with the exception of tobacco and hops.

In the Lower Island sub-region about 300 acres of land are ordinarily devoted to the production of bulbs such as narcissi,

[18]Mann, A. J. and Barnes, S., *Soil Texture in Relation to Tobacco Growing in British Columbia* (Dom. Dept. Agric., 1935).

tulips and iris. This type of agriculture requires a high degree of skill. Normally it faces severe competition from the highly reputed articles from Holland. As experience is gained, the Canadian bulb industry will doubtless enjoy a moderate expansion because climatic conditions are very favourable. In both the Lower Island and Mainland about two million square feet of land is enclosed by greenhouses. By taking advantage of the high percentage of sunshine, the higher temperature in winter, the cheap fuel and consequently the lower cost of heating greenhouses, the area is able to produce early vegetables for sale in the nearby cities and on the Prairies. Also each year several carloads of early rhubarb, tomatoes, and other products which have been grown outside under forced conditions are rushed by fast freight or express to consuming areas before their own locally grown supplies come on the market.

Quite different from the intensive highly specialized types of agriculture just described is the farming which is carried on in the more northerly parts of Cordillera Region. At several points in this large district there are fertile soils, notably around Smithers, Hazelton, and Prince George. In the Yukon Territory there are also small farming areas about Dawson and other mining centres. The climate shows marked differences in detail but in general it is characterized by extremes in temperature and a very moderate precipitation. The winters are long and cold but dry and therefore not unduly unpleasant. The summers, with their long periods of sunlight and moderate temperatures, are delightful. From an agricultural standpoint the districts suffer from a lack of moisture during the growing season and the possibility of summer frost. Grains, except barley, rarely mature though in favourable years they produce grain good enough for feeding purposes. Roots such as turnips, mangels and potatoes grow to large sizes though they have not the keeping qualities of articles raised farther south. They are too bulky to be

exported even when concentrated into bacon and ham. Most of the products raised on these pioneer farms are sold in nearby mining and lumber camps. In order to offset their remoteness from market some of the districts in British Columbia send out timothy and clover seed, valuable articles which are able to bear the high transportation charges. Difficulty is often experienced in getting suitable settlers for these regions.[14]

Forestry

A study of the economic geography of forestry in British Columbia falls naturally into a description of the physical resources, the methods of exploitation and the economic problems which have arisen in connection with the industry. The most valuable species is the Douglas fir[15] which thrives under the mild climate and heavy precipitation of Vancouver Island and of the lower coast of the mainland. It grows on good-quality soils up to an elevation of about 2,000 feet. The colder climate which exists above that altitude and to the north of the upper end of Vancouver Island reduces its size to unmerchantable proportions. Douglas fir grows in dense stands averaging about 50,000 board feet to the acre. The tree grows to heights of 300 feet and diameters of 10 feet, but commercial stands average 120 to 180 feet by 2 to 6 feet. Since it is intolerant of shade, the trunk is free of limbs and the timber of knots. The wood has great strength and shock-resisting properties and its durability, though exceeded by a few other species, is above the average of timbers generally. On account of these qualities Douglas fir is ideal

[14]British Columbia, *Report* (Victoria: Dept. Agric., 1940).

[15]Craig, R. D., "The Lumber Industry in Canada", *Canadian Geographical Journal*, vol. 15, November, 1937, pp. 224-48; Forest Branch, *Report*, (Victoria: Department of Lands) annual; Mulholland, F. D., *The Forest Resources of British Columbia* (Victoria: Dept. of Lands, 1937); McElhanney, T. A., and Perry, R. S., *Some Commercial Softwoods of British Columbia* (Ottawa: Forestry Branch, 1927); Whitford, H. N., and Craig, R. D., *Forests of British Columbia* (Ottawa: Forestry Branch, 1918).

for structural work of all kinds, especially for bridges, trestles and factory buildings where there may be sudden heavy loads. For these purposes large timbers 100 feet long and 3 or 4 feet square are often used. The smaller sizes are sold for dock works, piling, ties, silos and general construction. Some Douglas fir is used in furniture because it has a smooth attractive appearance and will take varnish well. It is suitable only for kraft paper since the pulpwood from it is dark and not easily bleached.

Western hemlock or Alaska pine, a quite different species from the low-grade Eastern hemlock, grows in the same general area as Douglas fir although it will thrive at higher elevations and in more northern districts than fir. In general it is inferior in quality to Douglas fir but not greatly so. It is of smaller size—2 to 4 feet in diameter and 120 to 160 feet high—may have knots, and is not quite as strong as Douglas. It is very susceptible to fungus and is used either where it is continuously wet as in submerged piling or continuously dry as in interior finish.

Western cedar is another valuable wood. Though it splits easily and is not strong, the oil which it contains makes it immune to fungus and remarkably durable. It is used for posts, piling and especially for shingles, as well as boats and canoes, chests and show-cases. Occasionally specimens attain heights of 200 feet and diameters of 15 feet but trees half or even one-fifth this size are used. The trees reach great age, those of 1,200 years sometimes being logged.

The Sitka spruce grows in dense stands, mainly in the Queen Charlotte Islands. It is almost as large as Douglas fir. It is free from branches for a good height and thus provides a high proportion of clear wood. It is strong and tough, easily seasoned, and of moderate durability, though it usually needs a preservative. In particular, Sitka spruce is light in weight and easily worked. It is in demand for aeroplane construction and is also used for cooperage, furniture and ladders.

Resembling Sitka spruce in some respects but less stiff and durable, is Engleman or Rocky Mountain spruce. This tree grows only in the interior where it constitutes the largest stand. It is satisfactory where strength is not of primary importance and where it will not be exposed to decay. It is employed for light inside construction, interior finish, boxes and shelving. It is excellent for pulp and paper. Western yellow pine also grows only in the dry belt. Because it is weak and very liable to attack by fungi, it is used for fruit boxes and rustic ceiling. Amabalis fir, lodgepole pine, and Western larch and other woods are of minor importance. Generally speaking, the better-quality woods and the largest stands are located along the coast while the poorer woods and more scattered stands are in the interior. North of the Jasper-Prince Rupert line of the Canadian National Railway the timber is of poor quality. Coast timbers are close to low-cost ocean transportation, have a more rapid rate of growth and experience a smaller fire risk than the interior reserves.

The methods of exploiting the forest resources of British Columbia differ so markedly from those in use in Eastern Canada that some description of them is necessary. The distinctive features of Pacific forestry are the enormous size of the individual trees, the density of the stand of timber, the rough terrain, and the absence of broad, comparatively smooth rivers down which logs might be driven. Growing out of these factors (which are the result of climate and topography) are a number of unique forestry techniques. Logging is carried on by machinery as much as possible. The lumber is cleared off the land by tractors and logging railways. Logs are never floated down-stream though they may be hauled in booms along the coast. Logging is a year-round occupation, not a seasonal one as in the East, but the camps usually close up for a holiday of two weeks at Christmas-time, and in the summer when the forests are dry and the

fire hazard great. Finally production is controlled by large companies. Typically a company will engage either in logging (i.e., getting the logs off the land) or it will own and operate a saw-mill. The saw-mill operator buys logs from outside logging companies, whereas in the East all the larger mills do their own logging and control their own timber limits. In the interior of British Columbia where the logs are smaller, the lumbering practices more closely resemble those in Eastern Canada.

Along the coast the method of logging varies from place to place depending on the terrain, the climate, the type of timber, and the density of the stand. Formerly the logs were dragged along the ground by a cable which was reeled in by a donkey steam-engine. The most common system today is the sky-line. Two strong trees several hundred yards apart are selected, trimmed of any lower branches and their tops cut off. These spar trees are then anchored to the ground by cables. Between the two spar trees a cable is securely fastened as high as possible above the ground. A travelling trolley or carriage runs along the cable or sky-line and from it a steel rope or choker line is fastened to the logs. When the choker line is reeled in by means of a donkey engine located at one of the spar trees, the logs are hauled toward the carriage and later, when the carriage moves along the sky-line, the logs with one end elevated above the ground are dragged to the head spar tree. The carriage and choker line are then hauled back for another load. By rigging a series of sky-lines the logs can theoretically be hauled any distance but costs increase directly with the number of donkey hauls and ordinarily after one or two moves by sky-line, the logs are loaded on motor trucks or on cars running on cheaply-built railways. The advantage of the sky-line system is that it is cheaper than the older methods of logging. It can be used on rough, rocky ground, on steep slopes and in rainy weather. The objection to sky-line logging is that the logs are hauled in a

direct line from the place where they have been felled to the sky-line and thence to the spar tree means that all the young growth along this route and, in effect, in all the area, is destroyed. This makes reforestation difficult.

Another common method of logging is by means of caterpillar tractors. The ends of a steel arch are fastened securely to either side of a tractor. A cable runs from a drum at the rear of the tractor through a roller at the top of the arch and thence to a choker line attached to the logs. When the cable is reeled in by rotating the drum, one end of the logs is elevated. With the other end dragging on the ground, the logs are pulled by the tractor along roughly-built roads to a yard. Usually they are then loaded aboard motor trucks or a logging railway for further transportation. The chief advantage of logging by tractors is that they destroy only a small proportion of the young growth and thus tend to conserve the forest wealth. The main limitation is that they cannot be used on steep slopes or on soggy ground. There are several modifications of these common logging methods.

After being hauled to the yard, the logs are transported by light railway or truck to tide-water. Trucks and trailers save the cost of rails, cars, and steam locomotives. They can tackle steeper slopes than railway trains but they are handicapped by wet ground and by the fact that a highway is about as expensive to build as the road-bed of a railway. After reaching tide-water the logs are securely fastened together in booms and towed by diesel tugs to a central point such as New Westminster, Vancouver, or Alberni. Towing is helped by the presence of long fiords and the protected channel in the sunken trough along the coast. The saw-mills are large in size and highly mechanized in order to handle the heavy logs. Mills at central points can be more carefully built and designed than scattered mills along the coast. Labour is more easily obtained. There is a market for the waste because the sawdust and edgings are sold as house-

hold fuel. Logs are much more easily handled in booms than sawn timber could possibly be handled in ships.

In British Columbia practically all logging involves clear cutting. Substantially all trees, certainly all those with a diameter at breast height of 12 inches or more, are felled and removed. Theoretically in any forest the trees are graded down by age groups in a regular manner from mature timber to seedlings.[16] Ideally, too, timber should be cut as soon as it matures so that, on the one hand, there is no wasteful decay and, on the other, no removal of "unripe" or undeveloped trees. Only the mature trees should be harvested, while the young plants are allowed to continue their growth until they reach their full stature.

As a matter of fact, however, timber does not begin to deteriorate as soon as it reaches maturity. It will "keep" for many years, especially if it has the capacity to resist fungus as many Pacific coast trees have to an unusual degree. Along the coast the forests have accumulated a great quantity of mature timber or timber which is past maturity but still of good quality. In the interior, fires which swept the district several decades ago destroyed all the trees above a certain age and the stand which began its growth subsequent to the widespread fires is now approaching maturity. Thus, both along the coast and in the interior a higher proportion of the trees are of a size suitable for logging than the theoretical distribution of growth among age groups would lead one to expect. Trees which should be marketed in small annual instalments are all ready for sale at one time. The conditions of growth thus favour clear cutting. Furthermore, logging is cheapest when most of the trees in one area can be felled at one time, for then the equipment can be used at full

[16]Brown, R. M., "The Forester's Viewpoint in Selective Logging", *Forestry Chronicle*, vol. 12, February, 1936, pp. 43-7; Harrison, J. D. B., *Economic Aspects of the Forests and Forest Industry in Canada* (Ottawa: Forest Branch, 1938); Godwin, "Regeneration Study on Vancouver Island", *Forestry Chronicle*, vol. 14, November, 1938, pp. 61-83.

capacity before being abandoned or removed. This is an important factor in British Columbia because the equipment is expensive to purchase and erect. Undoubtedly clear cutting produces timber at the lowest cost wherever the condition of the stand is suitable for its use.

The difficulty with clear cutting is that because almost all the trees are removed, few of the mature specimens remain to make seed available for a second growth. Also, the mechanical methods of logging destroy many of the smaller trees. Finally, the tops of the trees (slash) are allowed to remain on the ground. Until this slash rots after two or three years, it is very flammable and may catch fire due to lightning, human carelessness or sparks from adjacent lumbering operations. The fire spreads rapidly through the dry, scattered slash, kills seed trees, consumes humus in the soil, and generally prevents restocking of the land with good-quality trees. The blaze may also spread to nearby mature stands, devastating them. Furthermore, reforestation when it does occur may not be with Douglas fir but with lower-grade woods like lodgepole pine. All in all, clear cutting raises the serious problem of maintaining the productivity of forest lands. This is a matter of vital importance. At least one-third of the land area of British Columbia is forested, and most of the remainder is too high or rocky for any purpose except perhaps mining and hunting. Much of the forested land is suited only for tree growth. It can never be used for agriculture, due to excessive rainfall, steep slopes and remote location. If this land is to be productive of wealth at all, it must be used to grow timber. But it cannot continue to do this unless the cut-over land is adequately reforested with high-grade trees. Only about half the land at present being logged in British Columbia is properly regenerating itself. If present conditions are allowed to continue a decline in the output of forest products seems to be inevitable.

In an effort to prevent this decline, the provincial government

now requires that all slash be gathered, piled and burnt under official supervision. Reforestation is sometimes assisted by leaving a few isolated seed trees in the cut-over lands or by seeing that strips of trees along the edges of the logged area are given a chance to re-seed adjacent land before they themselves are removed. There has been much discussion of selective logging, that is, of periodically removing the fully mature trees and leaving the smaller specimens which are not yet of merchantable size, until they reach their full growth. Selective logging reduces some expenses per thousand board feet. Certain expenses such as felling, trimming, and hauling to the yard vary directly with the number of trees. When larger trees are logged these costs are unchanged in total but the cost per board foot is lessened. Crude roads have to be built to get out the timber. Though these are expensive to construct, they act as barriers against the spread of fire. Due to the larger amount of space available for each tree, the growth of timber in the three years following selective logging is equal to the growth in the previous ten. Higher prices are secured for the timber sold after selective logging than after clear cutting because the amount of low-grade, small-sized timber sent to the mill is much less. The chief objection to selective logging is that it is more expensive. Operations are spread out over a larger area. Money is tied up from year to year in logging equipment, which is not used to full capacity and which cannot be cheaply moved elsewhere. Also, it is costly to re-open the roads every few years. The lumber market is very competitive and normally the district which can sell its lumber at the lowest price gets the business. Clear cutting means a larger volume of business and bigger profits now at the risk of depleting the resource for future generations. Selective logging involves the loss of present income with the advantage of preserving and perpetuating the forest wealth. Severe competition has forced the province to choose the first alternative. With the exception

of a few experimental areas, clear cutting is the rule and reliance is placed on natural methods of regenerating forest growth in logged over districts.

Allied with the problem of reforestation is the fact that the timber resources, especially of the better grades, are being cut down faster than they are being replenished by growth.[17] In a typical peacetime year, British Columbia produces about three billion board feet of lumber of which one-half is Douglas fir. The total reserve of Douglas fir in the province is about 59 billion board feet but less than half of this is accessible. Only one-third of the accessible timber is located along the coast, which is the most favourable part of the province for ocean transportation, quick regeneration, and protection against fire. Accessibility means the possibility of getting out the timber at a cost less than the selling price. If prices go up or costs come down, due to improved methods of logging or better use of all parts of the log and so on, the amount of accessible timber is changed. No one can say definitely what accessibility will mean in terms of output ten or twenty years hence. In any case, the resource of Douglas fir will not last for many years—perhaps ten or fifteen—at the present rate of cutting. The prosperity of British Columbia forestry will then hinge on the ability of the industry to dispose of such lower-grade woods as cedar and Western hemlock in distant, highly competitive markets. Even if one includes all the standing timber in the province the reserve will not last more than 85 years at the current rate of cutting. If one includes all species believed to be accessible, the resource will last not more than 35 years. Conditions change so rapidly, however, that accurate prediction is impossible. Nevertheless, the problem of forest conservation is acute in British Columbia, perhaps more so than in any other part of Canada.

Most of the lumber cut in British Columbia is sold outside the

[17]Mulholland, *op. cit.*, pp. 45-61.

province. At one time the main market was on the Prairies but the slowing down of the rate of increase in the population there has reduced that outlet. In the 1920's the eastern seaboard of United States was the largest market but tariff increases by that country had a disastrous effect on exports in the early 1930's. Though the tariff was later somewhat modified in Canada's favour, the United States is less important than Great Britain, which was the largest market in the 1930's. Lumber is also sent to Australia, South Africa, and in peacetime, to the Orient. All of these markets are distant and the prosperity of the industry is partly dependent on the level of ocean freight rates. There is the constant threat of adverse tariff action. In most of the markets there is intense competition from closer sources of supply such as Scandinavia and Manchuria. So far, British Columbia has had an advantage on account of the superior quality of her Douglas fir. Due to the depletion of the Douglas stand, this advantage may be lost in a few years.

Because the forest resources are being used up at such a rapid rate, the Region is attempting to manufacture more and more of its timber before export. In this way it will provide for more employment within the province and will, perhaps, secure alternative types of work for the men who lose their jobs when the output of saw timber falls off. Newsprint is manufactured at Powell River and Port Alice. In future increasing amounts of lumber will probably be made into plywood before sale.[18] Formerly plywood was manufactured by glueing together thin sheets or plies of wood with the grain of alternate pieces at right angles to each other. Ordinary wood is much stronger when pressure or tension is exerted against the grain than with it, but plywood is of nearly equal strength parallel to and across the grain of the outer plies. Plywood was used for boxes and crates in place of

[18]U.S. Dept. of Commerce, *American Douglas Fir Plywood and its Uses*, (Washington: 1937).

heavier strips of sawn wood. It could also be used in interior finish. Low-grade wood in doors, frames, and other woodwork could be coated with thin strips of valuable woods like mahogany. Unfortunately, plywood could not be exposed to water or humid air for any length of time because the glue would cease to hold the plies firmly together. Recently, synthetic resins have been discovered which actually enter the fibres of the wood and set the plies permanently. Plywood can now be used in shipping containers which may be exposed to moisture, for forms into which concrete is poured, for railway cars, and in buildings generally. It is expected that plywood will be widely used within a few years, and British Columbia hopes that with her large forest resources and good transportation facilities she may become the centre for the manufacture of this product.

Despite the increased use of concrete, stucco, steel (in girders) and other substitutes wood is not likely to be made useless for construction because of its beautiful grain, the good finish it will take, its strength in proportion to its weight, its ease of working, and its cheapness. Therefore there will be a continuing demand for lumber. British Columbia's problem is partly one of transporting its forest products cheaply to distant markets and mainly one of conserving the supply.

Fishing

The fishing industry of British Columbia is based on, though not entirely confined to salmon just as the fisheries of the Atlantic coast of Canada are founded on cod.[19] Salt-water fishing is

[19]Alexander, G. J., *The Commercial Salmon Fisheries of British Columbia* (Victoria: Dept. of Fisheries, 1938); Babcock, J. P., "Salmon Fishery in the Fraser River District", *Annual Report Commission of Conservation* (Ottawa: 1918), pp. 140-7; British Columbia; *Report of Commissioner* (Victoria: Dept. of Fisheries), annual, *passim*; Carrothers, W. A., *The British Columbia Fisheries* (Toronto: University of Toronto Press, 1941); Cobb, J. N., *Pacific Salmon Fisheries*, Washington, 1930; Gregory, H. E. and Barnes, K., *North Pacific Fisheries* (New York: Institute of Pacific Relations, 1939); Freeman, O. W., "Salmon Industry of the Pacific Coast", *Economic Geography*, vol. 11, April, 1935, pp. 109-29.

always related to the geography of the coast and the habits of the fish themselves. The Pacific coast of Canada is peculiar. There is almost no coastal plain along the shore and no submerged plateaus or banks off shore. Lofty mountains border the coast-line or jut up in islands just off it and in Vancouver and the Queen Charlotte Islands. Just west of these islands the bed of the sea drops suddenly from about 100 fathoms below sea level to great depths. Between this 100-fathom contour and the shore, there is a network of submerged channels and inlets with comparatively deep water. Rivers flow into this channel either from the slopes of the Coast mountains or through the mountains from the interior. These rivers are important in the fishing industry especially when they have shallow lakes or pools of calm water in their upper reaches.

The waters along the coast are a mixture of warm waters brought by the Japanese Current which skirts the shore off Vancouver Island, the cold waters welling up from the depths, and the fresh waters from the in-flowing streams. The effect of the movements of water and of their differing salinity and temperature on the character of the sea life is even less well understood than on the Atlantic. This is due to the difficulty and expense of collecting data and to the fact that most fishing operations are carried on near the mouths of rivers rather than in the open sea, so that there is less commercial interest in marine "pastures".

The salmon-fishing industry cannot be understood without some knowledge of the habits of the fish itself. Each year in the late summer and fall some of the mature salmon swim from the salt water where they have spent the previous four years of their life up the fresh-water streams such as the Fraser, Skeena and Nass flowing into the Pacific. Having reached a suitable spawning grounds in the lakes and quiet shallow waters up-stream, the fish lay and fertilize literally millions of eggs in the gravel at the

bottom. The eggs hatch in about two months and the fry remain in fresh water, feeding and growing for from a year to 15 months before swimming down-stream to salt water. There they feed for about four years on grounds whose location is not yet definitely known.

Having reached maturity, the salmon return again to spawn usually, but not invariably, in the stream where they themselves were born. Once the full-grown salmon enter fresh water they stop feeding and begin to deteriorate in quality. In fact, shortly after they have reached their spawning grounds and laid their eggs, the salmon die, floating down-stream tail forwards. To be in good condition for human consumption the salmon must be caught before they reach fresh water. Because of this, and the greater ease of catching fish when they are congregated for a "run" up-stream, fishing operations are localized near the mouths of rivers. Salmon fishing and canning are seasonal industries.

The technique of fishing is quite different from that which prevails along the Atlantic coast. A few kinds of salmon can be caught by hook and line, but the more important commercial species must be secured by means of nets. About 40 per cent of the salmon are caught by gill nets which catch the fish by entangling their gill covers in the meshes of the net. The net, which may be 1,200 feet long and 60 wide, stands erect in the water suspended between cork floats at the top of the net and therefore at the surface of the water, and lead sinkers at the bottom of the net. The net is placed in the water by small boats across the probable path of the fish run, usually just beyond the mouth of a river. After the fish have become enmeshed, the net is pulled aboard the boats, the fish removed and the net replaced in the water. Most fishing with gill nets takes place at night or in cloudy weather, for on bright days the fish can see the net and avoid it.

About half the British Columbia catch is obtained by purse

seines. A net similar to a gill net is used, with the addition of a draw rope at the bottom. When a school of fish is sighted, one end of the net is attached to a dory which is kept in one spot while a power-driven boat makes a wide circle around the school, paying out the remainder of the net as it goes. One man in the dory continually throws a heavily weighted line into the water. The commotion he makes frightens the fish and prevents them from escaping through the gap between the ends of the net. Once the power-driven vessel has completed the circle and closed the gap, the draw rope is pulled as tightly as may be and the net hauled aboard the vessel by machinery. The net is thus constricted or pulled together like the top of an old fashioned purse. As the area circumscribed by the net becomes smaller, the fish get so thick in the water that they can be lifted, or brailed, aboard the vessel in scoop nets. These operations must be carried on at top speed because there is little to prevent the fish from swimming deep in the water and escaping underneath the net.

The remainder of the salmon caught in British Columbia waters are captured by beach netting. A net is paid out from a boat in a semicircle off shore and then the net, along with the fish which it has surrounded, is pulled onto a beach or sand-bar by horses or steam winches. There are also a few fish traps, pound nets attached to piles driven into the ocean floor off shore along the routes where the salmon commonly travel. Traps are so destructive of fish life that their numbers are limited by law in British Columbia and forbidden entirely in the State of Washington.

The fisheries of British Columbia are remote from large centres of population and therefore their salmon must be put in a relatively inperishable form before transportation to market. Small quantities are dried or salted; some is frozen and sent to Eastern markets during the winter; but the bulk of the catch is canned. The ideal location for a cannery is near the mouth

of a stream up which salmon "run", or at some other point adjacent to fishing centres. Often the cannery is not precisely at the mouth of the river, because the offal from the canning operations is dumped back into the sea and destroys fish life in the immediate vicinity. At all events, the cannery must be at some point where ample supplies of fresh fish can be quickly obtained. At the same time, good communication with outside points is essential. Supplies for the cannery such as tin cans, machinery and coal, food for the fishermen and the cannery workers, and often many of the workers themselves must be brought in, since this is a seasonal industry. Later the canned fish must be taken to a shipping centre, usually Vancouver. A safe, convenient harbour and a wharf are essential.

In Alaskan waters there are a few floating canneries, ships on which canneries are located, operating in the off-shore waters. The floaters supplement their own catch of fish by buying raw fish brought to them by independent fishermen or by a fleet of small ships which use the floating cannery as a base. The floater has great mobility; it can move around to locations where the catch is good, whereas the shore cannery may be seriously handicapped if the run in its vicinity is poor. The floater carries all its supplies with it and brings in the canned product, thus saving transportation costs. The chief limitation on their operation is that the vessel is expensive and can be used for only a short period each year. Typically it has higher costs of operation than the customary method. Up to the present all the floating canneries have been owned either by Americans or Japanese. Though Canadians have not directly participated in this new development they are affected by it in so far as they must sell their products in the foreign markets in competition with the output of floaters. Also they are concerned to the extent that the floating canneries may or may not be more destructive of fish life than shore canneries.

Both shore and floating canneries are highly mechanized. The fish are hoisted from the vessels to the cannery floor by means of conveyors. The heads, fins, and entrails are removed by the Iron Chink, a mechanical substitute for the Chinese who formerly did this work by hand. Stiff brushes remove the scales and powerful jets of water thoroughly clean the fish, which is then cut up and placed in cans along with the requisite amount of salt. The cans are weighed, vacuum sealed and then cooked in a retort for at least 90 minutes at 240 degrees Fahrenheit, the length of time depending on the type of salmon and the size of the can. After cooking, the cans are washed, cooled, painted with lacquer, labelled and boxed ready for shipment.

Cans are usually purchased cut out but not "blown up" because the complete empty cans are so bulky that the cost of transporting them to the cannery from the can manufacturing plants in Vancouver would be excessive. The machinery for assembling the various parts of the can and for creating the vacuum after the fish has been placed in it, is owned by the can manufacturer and leased to the cannery. All the other machinery in the cannery, such as the Iron Chinks and cooking retorts, is owned by the cannery operator who often also supplies some of the nets and other equipment needed by the fishermen.

The market for salmon within Canada is much less important than that abroad. About 70 per cent of the Canadian pack is normally exported, mainly to Great Britain and Australia, with smaller amounts to France, New Zealand and the Union of South Africa. Only a little over 10 per cent of the American catch is sent to foreign countries but since the British Columbia pack is only about one-fifth of that of Alaska, Washington and Oregon, American exports amount to nearly three-quarters those of Canada. Ordinarily the prices at which these two countries sell canned salmon abroad are about the same, because the dominant group in Canada works closely with a similar organi-

zation in the United States. In normal times the Japanese often cut prices, and Canadian and American producers faced keen competition from them. Canadian canners are also affected by the level of ocean freight rates, which assist or retard sale abroad. The industry has comparatively little to fear from tariff action, since the North Pacific is by far the world's most important source of commercial salmon.

The most intractable problem facing the industry is that of conservation. The avarice of commercial fishermen may lead to the depletion of any fishery resource but the danger is particularly acute in the case of salmon, because the most convenient place and time to catch the fish is when they are going up the rivers to spawn. Unless enough fish escape the nets to spawn, the numbers of fry may be so reduced that, after taking into consideration the loss from natural enemies, there will be no mature fish remaining to propagate the species. So long as there were only individual fishermen using hand nets and spears to get fish for their own immediate consumption, there was no danger of depletion. Bu· when a commercial market opened up and when nets, traps, and power-driven boats allowed fishing to be conducted on a large scale and with great efficiency, that is, with great destructiveness, the possibility arose of exhausting or greatly depleting a valuable resource. Depletion has been aided also by the pollution of salmon streams by newsprint mills and city sewage, and by the removal of the forest cover near the spawning streams. Sometimes man-made disasters like the rock slide into the Fraser Canyon at Hell's Gate during the construction of a railway in 1913 and sometimes the erection of power dams prevent the salmon from reaching their normal spawning grounds. In these cases the salmon, instead of laying their eggs below the obstruction, exhaust themselves in a futile attempt to get round or over the obstacle and die before they propagate their race.

Attempts at control have often failed in the past due to conflicts

in jurisdiction between the Dominion and British Columbia governments, and by the necessity of concurrent legislation by Canada and the United States if the fishermen of one country are not to benefit at the expense of the other. The international complication arises mainly in connection with the Fraser River which was at one time the most important salmon stream along the British Columbia coast but is now sadly depleted. In swimming toward the mouth of the Fraser, an all-Canadian stream, the salmon pass through waters on the American side of the Straits of Juan de Fuca and the Gulf of Georgia. The actions of fishermen in these waters are legally beyond the control of the Canadian government even though they may destroy a resource which reproduces itself in Canadian waters.

Efforts at control have been facilitated by the fact that salmon, for the most part, return to spawn in the river in which they were originally hatched. For this reason cannery owners drawing their livelihood from a particular stream may be more interested in conservation than if the necessity for conserving resources was presented to them in vague and general terms. More especially, measures of control can be applied so as to meet the needs of a particular stream; tailor-made, so to speak, instead of being of general and therefore often of improper incidence.

For many years the main measures for rehabilitating the industry took the form of operating fish hatcheries. Most of these were discontinued in Canada in 1927 because it was believed that artificial propagation was an expensive way of doing what could be done more effectively by protecting the streams from pollution and obstruction, and ensuring that enough fish "got by" the commercial fishermen at the mouth of the river to guarantee perpetuation of the resource. Elaborate regulations have been introduced limiting the number of fishermen who can participate in the fishing in certain areas, and controlling the size of the meshes. Commercial fishing is prohibited at certain

times, for example, on Saturdays and Sundays, thus allowing a good number of mature fish to escape up-stream. International measures of conservation did not become effective until 1945. Meanwhile, the salmon fisheries are being slowly rehabilitated, though it will take many years of careful control to restore the resource to its original productivity.

In addition to salmon, British Columbia is concerned with a few other fisheries products. Halibut spend all their lives in the cold waters along the coast, chiefly off Prince Rupert and to the west of Vancouver Island. Though often seen at the surface they commonly live near the bottom. When the halibut reach maturity, at the age of about 12 years, they weigh about 40 pounds, though specimens as heavy as 300 pounds have been captured. They are usually caught by allowing a weighted line about 60 fathoms long to sink to the bottom of the ocean. At intervals of about 13 feet along the "ground" line, hooks which are baited with fresh or frozen herring are attached on shorter lines. Six ground lines attached together form a "skate" and several skates a "string". The strings with their catch of fish are hauled aboard the deck of the fishing vessel by a power winch and the fish removed. Halibut has an unusually firm flesh and with proper care can be shipped long distances. Atlantic supplies of this fish are declining in volume and about three-quarters of the British Columbia catch, after being dressed and packed in crushed ice, is sent to Eastern Canada by express. The main centre of the industry is Prince Rupert which is nearer the most productive halibut fishing grounds than Vancouver.

By 1925 over-fishing had so greatly depleted the supplies of halibut that the United States and Canada agreed to conserve the remaining resources.[20] The treaty has been entirely successful in its objective. Fishing for halibut is forbidden during the winter months, when spawning occurs. A limit is placed on the

[20]Adams, J. Q., "Pacific Coast Halibut Industry", *Economic Geography*, vol. 11, July, 1935, pp. 247-57.

catch of each vessel on every trip and a lay-off is provided between trips. Since the total catch in any one year is fairly well known in advance, the price is more stable than formerly. Also, the catch per "skate" has increased; the more accessible grounds have been restored to production and, as a result, costs have been reduced. There are immediate business gains as well as long-run economic and social benefits from conservation.

Herring in British Columbia is important mainly for its oil.[21] The sale of salted and kippered herring has almost disappeared. Herring and pilchard, another oil producer, are caught by purse seines, the former in shore during the fall and winter, the latter off the lower part of Vancouver Island from June to October. They are cooked in large retorts and while still hot are compressed to remove the oil. The solid matter which remains is ground into meal and sold for feeding to cattle and poultry. Oil can also be extracted from the viscera of salmon. Every cannery has a supply of such wastes but the extraction plants are so expensive that it is not profitable to have one at every cannery. At the same time, it does not pay to transport the wastes from scattered canneries to a central oil-reduction works. Fish oils vary greatly in their chemical and physical properties. Oil from the livers of cod, halibut, and dogfish has a high vitamin content and is used for medicinal purposes. Oils from other species of fish are used for lubricants, fine paint, varnishes, edible fats and soaps. The oil resources of sea life are being rapidly developed.

Though not biologically a fish, a few whales are caught each year by ships operating from two stations on Queen Charlotte Islands. The carcasses are towed to the shore stations for the reduction of oil, the canning of whale "beef" for sale in the Orient, and the production of animal feeds and fertilizers from the residue. The size of the catch is declining.

[21]Carter, N. M., "Oil from the Sea", *Canadian Geographical Journal*, vol. 15, December ,1937, pp. 305-13.

The Pacific seal is biologically a sea-lion. Unlike the true seal of the Atlantic, it is killed chiefly for its fur, though recently the carcasses have been used for oil and meal. Indiscriminate killing so greatly reduced the number of animals of the Pribilof Islands, which are the main breeding grounds, that the nations concerned with sealing agreed, in 1911, on measures of conservation.[22] The entire resource was put under the control of the United States. Under competent supervision the industry has been restored to something approaching its original prosperity. The profits of the industry are divided among the different countries in an agreed ratio, the Canadian share (15 per cent) being about 10,000 skins annually. Just before the outbreak of war in the Pacific, Japan abrogated the agreement and the post-war position has not yet been determined. Just off Canada's Pacific coast another species of sea-lions—the so-called trained seals of the circus—live. These are of no great economic value in themselves and they consume large amounts of commercial salmon. The provincial government pays a generous bounty for their destruction and each year a few vessels go out to "catch the bounty".

The small native oysters of the Pacific coast have been practically destroyed by greedy fishermen and the pollution of the water. Baby oysters, "seed", have been brought in from Japan or from Chesapeake Bay and have thrived. There are a few attempts at aquiculture, that is, "cultivation" of oyster beds.

Mining

The Cordillera Region is pre-eminently a mining one.[23] The placer-gold mining which first attracted settlers to the Fraser, Cariboo and Klondyke districts has virtually disappeared. In the

[22]Howay, F. W., Sage, W. N., and Angus, H. F., *British Columbia and the United States* (Toronto: Ryerson Press, 1942, pp. 317-29).

[23]*Report* (Victoria: Department of Mines), annual; Innis, H. A., *Settlement and the Mining Frontier* (Toronto: The Macmillan Company of Canada Limited, 1936).

Klondyke the gold-bearing gravels are being worked over by steam shovels but the value of the output from the Yukon, which reached a maximum of $22,275,000 in 1900, declined to about $3,000,000 in 1939.

As placer mining declined, hard-rock gold mining has tended to increase in importance. Gold has been discovered and mined at several points in the granite rocks of the Coast range batholith, and in corresponding formations on Vancouver and the Queen Charlotte Islands. The chief centres of production at present are near Bridge River on the Pacific Great Eastern Railway about 150 miles north and slightly east of Vancouver, at Hedley 125 miles due east of Vancouver and at Zeballos on the west coast of Vancouver Island. Smaller producing mines are scattered throughout the southern interior. Copper is mined both in the metamorphosed sedimentary rocks of the southern interior at Allenby near Princeton, 125 air-miles east of Vancouver, and also in the batholith at Britannia on Howe Sound a few miles north of Vancouver. The ores carry less than 2 per cent copper along with low values in gold and silver. The works at Anyox on a branch of the Portland Canal, which were at one time the second largest in the British Empire, were abandoned in 1939 due to the exhaustion of the reserves.

Deposits carrying silver, lead, zinc and other materials in varying proportions occur in many districts, chiefly in Precambrian rocks of southern British Columbia. The most important single mine is the Sullivan near Kimberley in the Rocky Mountain trench. In normal years this one mine produces about 11 per cent of the world's supply of lead, 8½ per cent of the world's zinc and nearly two per cent of the world's silver. It also produces gold, copper, antimony, cadmium, bismuth, and its ores contain large amounts of iron and some tin. Its reserves are great and it is undoubtedly one of the world's greatest mines. There are a number of smaller mines of the same character else-

where in the southern interior. Silver-lead ores are mined near Mayo in the Yukon Territory.

Although the uses of most of these minerals are well known, a few of them are unusual. Antimony is one of the few minerals which has the property of expanding on cooling and contracting with heat. It is used in alloys such as type metal to counteract the effect of other metals which re-act in the opposite way to changes in temperature. Cadmium, a bluish-white, easily-worked metal, is used in photography, for giving a yellow colour to porcelain, and to enable other metals to fuse at lower temperatures. Bismuth melts at lower temperatures than other metals and is employed in automatic sprinklers in buildings, where a rise of temperature due to the outbreak of fire will melt the bismuth and release water.

Coal is widely distributed throughout the Cordillera Region. At Nanaimo, on Vancouver Island directly opposite the city of Vancouver, a total area of 65 square miles is underlain by bituminous coal of fair grade. Most of the seams are much faulted and some of them extend out under the sea. They are also irregular in thickness, varying from a few inches to over 30 feet in a lateral distance of 100 feet. At Comox, a few miles farther north, good coking coal is present though the quantity is, as yet, not accurately determined.

In the Crowsnest Pass near Fernie there is the largest deposit of first-class coal in the Cordillera from Alaska to Mexico. The seams are thick and regular. Unfortunately, the over-burden is heavy and mining operations have had to contend with large amounts of deadly methane gas. The coal, a high-grade bituminous, is excellent for both coking and steam-raising purposes. It is widely used throughout the Prairies and British Columbia but the American market is cut off by tariffs. Near Canmore in the Bow River Valley there is a relatively small deposit of high-quality coal, used chiefly by railways. There is some production of

fairly good coals in the Nicola Valley from Merritt to Princeton. Large reserves are said to exist in the basin of the Groundhog River, 80 miles northeast of Stewart, but their remoteness is a serious limitation on their exploitation. Some coal is obtained along the Yukon River to fill local mining and domestic requirements.

Deposits of iron ore occur in many localities in the Region—near Kamloops, in the Taseko Valley west of Lillooet, and chiefly along the coast. On Texada Island, 75 miles northwest of Vancouver, and along the west coast of Vancouver Island, reserves variously estimated to contain from 250,000 to 4,500,000 tons are present. They are close to tide-water and can be mined cheaply. Low in sulphur, free from phosphorous, and with a ferrous content of 50 per cent, they are rated as being fair in quality. They are mainly magnetite, a type which heretofore has been used only for mixing with other types of ore and with scrap iron. The difficulties in using the magnetite ores as the sole ferrous raw material for producing pig iron are probably not insuperable, but the risk of running into unforeseen problems has deterred development.

Non-metallic minerals are also found in this Region. A large body of gypsum occurs at Falkland in the upper Okanagan Valley, and rock suitable for manufacturing cement is present near Victoria. Important chemicals like magnesium sulphate, sodium sulphate, and sodium carbonate have accumulated on the bottom of some of the lakes in the interior dry belt. Talc, mica, and asbestos have also been discovered but their commercial value has yet to be established. At Pinchi Lake, northwest of Prince George, in 1938 two young University graduates discovered what was to become one of the great mercury mines of the world. Mercury was formerly used extensively in the extraction of gold but its chief uses at present are as a detonator in high explosives, in red paint for preventing fouling on the bottoms of ships, and in medicine.

Mining in the Cordillera Region has faced a number of unique problems. One of these is the complex nature of the ores. The great resources at the Sullivan mine were not used from 1907 to 1923 although they had been known and to some extent exploited for silver and lead for some years previously. The reason for the abandonment of the mine after 1907 was that the ores were so unusually complicated that the several minerals contained in them could not be separated from each other and from the barren rock in which they were located. This difficulty was finally overcome by Canadian scientists through the perfection of the flotation process which will be outlined in connection with the Shield.

Ores from the Sullivan and other mines are smelted and refined at Trail by processes which are too involved to be described here. The Trail smelter is the largest non-ferrous metallurgical plant in the world.[24] Before the outbreak of the second World War its capacity was 450 tons of lead, 400 tons of zinc, and 70 tons of copper every day, 40 tons of cadmium every month, and gold and silver in addition. The plant uses hydro-electric power developed along the Kootenay River below Nelson and along smaller rivers in the vicinity of the smelter. For many years the sulphurous fumes given off during the smelting process were allowed to escape into the air and were carried by the prevailing winds down the Columbia River Valley across the International Boundary, 12 miles away from the plant. Since these fumes destroyed all the vegetation in their path, the American government protested to the Dominion. The matter of damages was amicably settled by the Joint International Boundary Commission. To prevent the destruction recurring, the smelter in 1930 erected a plant to extract the dangerous sulphur dioxide from the fumes and convert it into sulphuric

[24]Sheffield, P. H., "The Trail Metallurgical Plant", *Canadian Geographical Journal*, vol. 3, September, 1931, pp. 177-97.

acid. Nitrogen is secured from the air and hydrogen from water by electrical means. Phosphate rock is obtained from Montana. By using all these raw materials the smelter is able to manufacture fertilizers of various kinds. These are sold to farmers in British Columbia. Increasing amounts will probably also be sold to agriculturists on the Prairies as the need for replenishing the mineral constituents of the soils comes to be better realized and the income of the farmers rises to the point where they can afford to buy fertilizers. The development at Trail is of great significance to Canada from both a commercial and an agricultural point of view.

Aside from the complicated character of the ores, a further problem of mining in the Region is the difficulty of exploring the terrain. Large areas are still unprospected and accurate geological maps have not been prepared for more than a quarter of the province of British Columbia. Many deposits discovered years ago could not be profitably worked because of lack of transportation facilities or inability to handle the very complex ores by the crude metallurgical processes known at that time.

In the Yukon and along the northern coast of British Columbia, the climate in some places hampers mining. In 1896 gold was discovered among the pebbles and sands of the Klondyke River and its tributaries. Because the gold could be so easily secured, these deposits were quickly depleted. At present gold is secured in the Yukon mainly from gravels located close to the bed-rock or within the broken and decomposed rock above the solid undisturbed schist.[25] The gold is covered with as much as 150 feet of gravel, sand and moss. This overlay is perpetually frozen and has to be thawed out before it can be mined. After many attempts to thaw it economically by means of heated rocks, wood fires, hot water, and steam, it was found that cold water was satisfactory, provided it was available in adequate amounts.

[25]The Yukon Territory (Ottawa: Dept. of Interior, 1926), pp. 21-58.

Steel pipes sharpened at one end are driven into the frozen ground and water forced into them under pressure. The water escaping through holes at the end of the pipe thaws out the gravel ahead of dredges which scoop up the sand. Later the sand is washed and the heavy gold which sinks to the bottom of the sluices is removed. Hydro-electricity or coal is used to supply power to the dredges and water is brought long distances by flume. Operations must cease during the winter.

In northern British Columbia the chief difficulties with mining are deep snows and steep slopes. One Canadian mine is connected with the sea at Hyder, Alaska, at the head of the Portland Canal, by an aerial tramway 11 miles in length, along which all ore is shipped out and most freight is brought in. The mill which extracted gold from the ore in another deposit in the same vicinity was located entirely underground.[26] The surface above the mineral deposit is rough and mountainous. The average snowfall is about 60 feet per annum and at least 15 feet of snow covers the ground throughout the winter. No mill site above ground is free from serious snow slides in the spring. A road to reach the outcrop of ore could be built and maintained only at prohibitive cost. Hence a tunnel was driven into the mountain from the western slope below the known ore bodies and a mill site excavated underground. The only other subsurface mill in the world is in Colorado.

The complexity of the ores, the difficulty of prospecting such a mountainous region and the cost of overcoming the severity of the climate in the north are all handicaps on the mineral development of the Cordillera Region. In addition, there is the cost of constructing and maintaining railways and other transportation facilities over such a rough terrain. Usually there are no other

[26]Campbell, D. S., "Underground Mill Excavation at Big Missouri Mine", *Trans. C.I.M.M.*, 1938, pp. 317-27; Dolmage, V., "The Present Status and Future Possibilities of the Mining Industry in British Columbia", *Bulletin of Imperial Institute*, 1928, pp. 69-150.

industries to share the cost of railways with the mines, because any lumbering and agriculture which may develop along the lines will be dependent solely on the success of the mine. The Region has a great variety of minerals, many of them in large quantities. Much of the area has not yet been thoroughly explored and new mines will doubtless be discovered. New uses for minerals, new metallurgical practices, and cheaper transportation facilities may be expected to develop mineralized districts which cannot be opened up with the current level of costs.

Hydro-Electric Power

The amount of water-power which it is theoretically possible to develop in the Cordillera Region is very great. The potential supply of electricity is the result of geographic factors but how much will actually be produced is determined by engineering and economic forces.

From a physical point of view the amount of energy obtainable from a given stream is dependent on the volume of water and the height it falls in its course.[27] The generally high rainfall and rough terrain of the Region give it an initial advantage in these respects. The rivers of British Columbia can be divided into three classes from the standpoint of their value as potential sources of hydro-electricity. Along the coast are numerous

[27]Creager, W. P., and Justin, J. D., *Hydro-Electric Handbook* (New York: John Wiley & Sons, 1927); Barbour, G. B., "Harnessing the Columbia River", *Geographical Journal*, vol. 46, October, 1940, pp. 233-42; Conway, G. R. G., *Water Powers of British Columbia* (Ottawa: Water Power Branch, 1915); Gray-Donald, E. D., "Some Considerations Governing the Undertaking of Hydro-Electric Power Developments", *Engineering Journal*, vol. 18, November, 1935, pp. 497-501; Nelson W. R., "The Boulder Canyon Project", *Ann. Rpt. Smithsonian Institution*, 1935, pp. 428-52; Williams, F., "Water Power and its Conservation", in Parkins, A. E., and Whitaker, J. R., *Our Natural Resources and their Conservation* (New York: 1936) pp. 309-40; Natural Resources Committee, *Energy Resources and National Policy* (Washington: 1939), pp. 237-80, 298-313; Johnston, J. T., "The Water Power Resources of Canada and their Utilization", *Canada Year Book*, 1940, pp. 353-64.

streams, rather short in length, rising west of the Coast Range or flowing from the mountains of Vancouver Island into the Straits of Georgia, Queen Charlotte Sound or Hecate Strait. These rivers are fed by the copious rains which fall on the mountains, mainly in winter. Although the rivers fall abruptly, development is restricted by the remoteness of the power sites from the present centres of population and the irregularity of the flow.

The second group of streams include the Fraser and the Skeena which, after rising in the interior plateau, cut through the Coast Range in deep canyons. The flow of water in these rivers is rather more regular than in the coastal streams but still has considerable variation. The final group comprises those rivers which are confined entirely to the interior plateau, either because they are tributaries of the Fraser and Skeena or because, like the Columbia, they leave Canadian territory before penetrating the Coast Range. The annual rainfall in the drainage basins of these streams is less than along the coast but the lakes which occupy parts of the valleys between the mountains provide natural storage basins and the flow throughout the year is fairly even.

In the generation and sale of hydro-electric power the regularity of flow is of great significance. In any project the cost of dams, flumes, generators, transmission lines and so on is large. If rainfall is low at certain times of the year the amount of power which can be developed then is small. At other seasons, when rainfall is ample, large amounts could be generated. It is conceivable that one might find an industry whose power requirements synchronized with power output, one whose needs were low when little power was available and high when large amounts could be created. Such industries are unlikely to exist. Generally speaking, the requirements of most industrial and commercial and domestic users are fairly constant throughout the year.

As a result, a company considering developing a power site where the flow is quite irregular is faced with two alternatives. Either it must restrict its market during the entire year to an amount no greater than it can supply at times of minimum flow, or it must erect dams to store water in order to provide a higher, more regular output of electricity. The electricity itself cannot be stored from high- to slack-water periods. Under the first alternative power goes to waste and the interest charges on the generating and transmission systems must be borne by a small output. Under the second alternative heavy expenses are incurred for storage facilities. In either event costs are increased. In short, one of the most important features of hydro-electric power is the amount of "firm" power available throughout the year. British Columbia is handicapped by the irregularity in the flow of its streams especially along the coast.

The Cordillera gains, however, because the dams can be erected on hard rock foundations. In Regions like the Prairies and the Lowlands where the soil cover is deep it is difficult and expensive to anchor dams so that they will not be carried away by floods, and hard to construct them so wide and deep that the impounded water will neither escape around the ends or seep through underneath the concrete. Also, in British Columbia, the land above the dam site is often of little agricultural value and can be flooded without incurring charges for damages to other property. In the East the cost of compensating farmers and others for loss of property values may be so great as to offset the gains of getting more "firm" power. The only parts of British Columbia where there might be a conflict between the needs of agriculture and those of power are in the irrigated sections of the interior. Fortunately the long narrow lakes already provide adequate and economical storage facilities. Along the Fraser and Skeena large dams would necessitate re-location of railways. Along the coast the rivers fall steeply and any dam

constructed to impound a large volume of water would have to be high and hence expensive.

In almost all the dams, facilities would have to be provided for allowing mature salmon to ascend the rivers to spawn. This can be done by building a long spillway or ladder with steps no more than one foot high. The volume of water coming down the spillway is very carefully regulated so that fish may be able either to jump or swim against the current from one step to the next higher one and thus to the top of the dam. Of course, there is some loss of water and therefore of potential power and there is considerable expense in constructing the spillway, but it is essential that the fisheries be preserved. It is claimed that it is not necessary to make any special provision for guarding the young salmon fry going down-stream for, even when they go through the turbines, they are adequately protected by the "cushion" of water about them. Even so, the American schemes of using fish ladders have not proved entirely successful.

All in all, power development in British Columbia is likely to be a costly proposition. Nature freely provides large amounts of water falling precipitously but it is typically expensive to exploit the resource by harnessing the forces of nature. Some British Columbia sites could be more cheaply developed than others. For example, a relatively short tunnel could be driven through the rock from the western slope of the Coast Mountains to Chilco Lake on the east side of these mountains. During the period of low rainfall along the coast, water could be brought from the lake to a power site on the coastal side of the mountain. In this way a large amount of firm power could be developed cheaply but on most sites hydro-electric power can be generated only with great capital investment.

Due to the huge sums of capital required, any lowering in the rates of interest at which money can be borrowed tends to speed up development. The increasing use of light metals such as

aluminum would also accelerate matters. The mineral raw material, bauxite, could be brought in cheaply by water from British Guiana or the Dutch East Indies; reduced to aluminum by hydro-electric power; and the finished article could either be further processed on the coast or exported in bars and billets. Similarly, the various kinds of native ores of British Columbia could be treated electrically as is already partly the case at Trail. It is unlikely that electricity will be used in manufacturing where great heat is required, as in iron smelting, but it may be used for producing a few high-grade ferrous products where rigid control of temperature is essential.

In the Pacific Region electricity has to compete with other forms of heat and power such as coal from Nanaimo and Fernie, and oil brought in cheaply by water from California. Electricity is undoubtedly superior for lighting and domestic power (vacuum cleaners, radios and refrigerators). It is rarely used for transportation except in cities and suburban districts where the traffic is heavy enough to pay for the high capital expenses involved. Neither is it employed for space heating except for small surfaces and short periods of time (flatirons, toasters, ranges, and water-heaters). Another factor affecting its use is that some enterprises, like universities, hospitals and factories, have to use coal for heating and can develop their own electricity without much additional expense. Saw-mills have a good deal of waste material which it is cheaper to use to produce power for the mill machinery than to throw the waste away and purchase power from hydro-electric central stations.

Finally, the total consumption of hydro-electricity is dependent in part on the size of the population in the adjacent region. With our present knowledge and with existing costs of building transmission lines it is not economical to send electricity for more than 250 to 300 miles. Hydro-electrical development along the coast has been favoured by the heavy concentrations of popula-

tion in the lower Mainland and lower Vancouver Island, by the consistent growth in numbers and by the possibility of locating the factories where cheap water transportation can be secured and bringing the power to them. A hydro-electric power site cannot usually be developed in piece-meal fashion. The dam, generating and transmission systems and so on must be built almost to their full capacity at one time. Because of this, a market for very large amounts of energy must be available as soon as possible after the works are finished and so the problem of getting a market for the power is often an acute one.

It is clear that the probable future course of hydro-electric development in the Cordillera Region will be affected by a great many factors. The engineering features like stream flow, design of plant, location of transmission lines and so on, are not definite but can be ascertained within a relatively small margin of error. The economic factors are more intractable—the trend of interest rates, the possibility of shipping raw materials and finished goods by water at low rates, the competition of coal and petroleum, and the probable future market. All that it seems safe to say is that the Region has great potentialities. It is likely that the power sites of the Region will be developed mainly under government auspices because the projects have many purposes—power, irrigation, navigation, flood control, and fishery conservation. A privately-owned enterprise tends to be interested primarily in the power and will neglect the other aspects with which the public at large is greatly concerned.

Manufacturing

British Columbia stands third among the provinces of Canada in manufacturing but it is a very poor third indeed, with only 7 per cent of the total Canadian output. The industries already established may be divided into three groups. The first includes perishable articles like bread, meat and newspapers, or articles

which acquire bulk in the process of manufacture such as aerated waters, doors, furniture, cooperage, coffins, and many more. All these must be manufactured close to market.

The next group of industries are those concerned with reducing the bulk or rendering less perishable certain locally produced raw materials. In this group are the fish curing and canning plants, fruit and vegetable canneries, pulp and paper mills, sawmills and so on. The chief long-run problems faced by this group of manufacturers are the depletion of resources and access to overseas markets. The prosperity of this group is sensitive to changes in foreign tariffs and in ocean freight rates.

The final group exists because of the ease of bringing in raw materials from tropical and semi-tropical climes, processing them and then sending them on to markets in Western Canada. In this category must be included the blending and packaging of tea, coffee, and spices, the refining of sugar cane, and the extraction of oil from copra or dried meat of the coconut. The oil is used in the manufacture of soap, while the cake which remains after the oil has been removed makes valuable feed for dairy cattle. It is more economical to extract the oil in Canada than in the tropics where the coconuts are grown. The natives are inefficient workers. The oil may become rancid in hot climates and cannot be shipped as easily as the copra. In the tropics, there is no market for the oil-cake because there is no dairy industry. It is cheaper to extract the oil on the Pacific coast than in Eastern Canada because every 100 tons of copra will produce only 65 tons of oil and so removing the oil before beginning the long and expensive rail haul cuts down costs.

The industries established on the Pacific coast largely as a result of the second World War may become permanent. In shipbuilding, British Columbia has the advantages of a mild climate which permits work outside most of the year round. It also has ample supplies of good, cheap timber for staging during construc-

tion and interior finish within the ship. On the other hand, wage rates are high due to the high standard of living prevailing on the coast. Steel is expensive because it must be brought in from distant points. Finally, the amount of shipping space relative to the demand for it is likely to be very great after the war.

The production of aeroplanes, another "war baby", has a brighter future. Transoceanic and transcontinental services, possibly even private flying, will boom. In the construction of planes British Columbia has a great advantage over other parts of Canada on account of its mild climate. This is important, because planes must be assembled in large buildings without upright supports from the middle of the floor to the roof. When the weather is cold the cost of heating a large building is great. If the snowfall is heavy the expense of building a hangar with a roof strong enough to withstand the weight of the snow is considerable. The mild weather also permits planes to be tested outside, although the prevalence of fog in the Vancouver area is a drawback. The chief handicap is that, due to the vast facilities built during the war, the industry will shrivel badly after the war is over.

Altogether, manufacturing in the Cordillera Region has made definite progress in manufacturing along a few lines and shows promise of more substantial development in other directions.[28] Following the cessation of hostilities the Vancouver area experienced a large influx of population and there was increased interest in the Region by capitalists in Eastern Canada and the United States. Because many of the resources of the province are of a wasting character, it is essential to its continued prosperity that it should manufacture as many of its raw materials at home as possible. Only in this way is the province likely to be able to provide

[28] Lomax, A. L., "Manufacturing in the Pacific Northwest", in Freeman and Martin, *op. cit.*, pp. 439-62.

employment for its citizens when its minerals and lumber will have been depleted.

Recreation

The Cordillera Region has many important tourist attractions.[29] Some of these, like Lake Louise and Banff National Park, are world-famed. Others are less well known. Within the Rockies, in Jasper Park there are glaciers still in existence and evidences of past glaciation in U-shaped valleys, cirques, and hanging waterfalls. Ski-ing, golf tournaments, games of the Scottish Highlands, horse-back riding along mountain trails, hunting game such as bear, mountain goats and sheep—all these attract their devotees. Along the coast tourists can travel by steamer along the submerged valley between the mainland and Vancouver and Queen Charlotte Islands. They can see in comfort high mountain peaks, fiords, glaciers, hanging waterfalls and majestic forests. If they wish, they may travel over the steep grades of the narrow gauge White Pass and Yukon Railway on which it sometimes takes five locomotives to move a train with a dozen passenger coaches. Thence they may go by paddle-wheel steamer down the Yukon River to fabulous Dawson City. On Vancouver Island, Victoria with its old-world atmosphere has a charm all its own. On account of its climate it is justified in calling itself "Canada's Evergreen Playground". Both in Victoria and in Vancouver golf has been played every day in the year. Rain never stops the enthusiasts though light falls of soft snow usually prevent play for a few days each winter. Skylarks brought originally from England live in meadows near Victoria, one of the two or three places outside of their native habitat where they have thrived.

The tourist industry is handicapped by the remoteness of the

[29] *Advertising Campaign for the Promotion of Tourist Travel* (Victoria: Government Travel Bureau, 1940).

Region from large centres of population and the inaccessibility of some of the most spectacular attractions. The only large cities along the coast—Seattle, Portland, San Francisco, and Los Angeles—have nearby natural attractions of their own and the latter city is nearly 1,500 miles from British Columbia. The cities of the American Mid-West and the Atlantic coast are still farther away. The wealthy may come by train, but the tourist by automobile and trailer finds the distances too great and the scenery of the intervening plains too monotonous. Yet in peacetime tourists were arriving in increasing numbers every year. Cheap travel by air after the war may lead to a flood of tourists but distance and the competition of districts nearer the centres of population will still be a handicap.

Up to the present the railways and steamships along the coast have provided the chief means of transporting tourists. They give good service and have constructed excellent hotels and tourist lodges. They go within sight of the highest mountain peaks and traverse districts of great beauty. The modern tourist, however, prefers to travel by automobile. The cost of constructing and maintaining highways in mountainous territory is very great and the roads are not always paved or properly equipped with guard rails at dangerous points. This is being rapidly rectified. The Dominion government has built a first-class road connecting the two National Parks at Banff and at Jasper. Another good road has been constructed between Banff and Windermere in the Rocky Mountain trench. The Alaska Highway has been built from Edmonton through the Peace River country to Dease Lake, Whitehorse and on to Fairbanks, Alaska, by U.S. Army Engineers and Canadian civilian contractors. If tributary roads are built through the interior of British Columbia and from coast towns like Prince Rupert, and Skagway, the highway may open up the northern sections of the Region to tourists. On account of the distances involved it is unlikely that

the amount of tourist business will ever be large but considering all the natural attractions of the Region the tourist business will inevitably grow, provided good roads and aeroplane landing fields are available for use.

General

The Cordillera Region probably has a greater diversity of resources than any other part of Canada. Unfortunately, its main sources of wealth—mining, forestry, and fishing—are subject to depletion, though the last two are not necessarily so. Only its agriculture, water-power and tourist attractions are permanent. The fundamental problem facing the Region is the need for conserving wasting resources and developing new types of economic activity to provide a high standard of living for its people.

CHAPTER VI

THE CANADIAN SHIELD

THE CANADIAN SHIELD, also known as the Laurentian Upland or the Precambrian Shield, surrounds Hudson Bay on the east, south and west like a gigantic horseshoe. Its total area is about two million square miles, or over half that of all Canada. The Shield includes all Labrador and the province of Quebec north of the St. Lawrence River, with the exception of a narrow plain along the St. Lawrence and Ottawa rivers from Quebec city to a little beyond Hull. It incorporates all of Ontario west of Renfrew and Brockville and north of a line from Kingston to the lower end of Georgian Bay. The Shield also extends into the United States where it includes part of New York state, the upper peninsula of Michigan and the northern part of Minnesota. Re-entering the Dominion near the southeastern corner of Manitoba, the boundary of the Shield runs northwesterly through lakes Winnipeg, Great Slave and Great Bear to the Arctic shore near the mouth of the Mackenzie. It does not include the coastal plain around the southern parts of Hudson and James Bay nor any of the islands in the Arctic Archipelago though rocks of the same character as those of the Shield are present in some of them.

The boundary between the Shield and the Prairies as well as between the Shield and the Lowlands is marked not so much by differences in elevation as by differences in soil and the human use of resources. North of the St. Lawrence the boundary is clearly distinguished by the so-called Laurentide Mountains which rise abruptly to elevations of about 2,000 feet above the Lowlands bordering the river. The term "mountain" is really a mis-nomer since the crest of the Laurentides is uniform in eleva-

tion with the Shield which stretches northward for hundreds of miles. At best, they are one-sided mountains, the dissected edge of the Shield.

As one would expect from the fact that the Shield covers a range of latitude from about 44 to 70 degrees, the type of climate and native vegetation varies considerably. In the south the Shield is covered with coniferous forests of balsam fir, spruce, tamarack and jack (banksian) pine. In the northern Shield there is a tundra vegetation of shrubs and other plants adapted to a short growing season. Between the two biotic areas is a broad transitional zone where trees are scattered either singly or in clumps among the low shrubs of the Tundra. The forest cover is heaviest along the banks of the rivers where drainage is more satisfactory and there is some shelter from the bitterly cold winds blowing across the northern wastes.

In the southern half of the Shield the chief industries are mining, forestry, and the generation of hydro-electric power with some agriculture and fur trading. In the Tundra section economic activity is restricted to fur trading, though a little mining is also carried on. The physiographic province of the Shield does not coincide with the human use of resources. Therefore the general plan of the book of using topography as the basis for de-limiting the various Regions of Canada has been departed from. A geographic province—the Shield—has been divided into two economic areas—the Shield and the Tundra.

Topography

The Canadian Shield is distinguished by the sameness of the physical features over its enormous area.[1] Viewed from the air,

[1]Atwood, *op. cit.*, pp. 147-82; Blanchard, R., *L'Est du Canada Français*, Montreal, 1935; Collins, W. H., "The Geology and Physical Geography of Canada", *Handbook of Canada* (Toronto: University of Toronto Press, 1924), pp. 346-74; Dagenais, P., "La Région des Laurentides", in Minville, *op. cit.*, pp. 107-30; Young, *op. cit.*, pp. 6-67.

the landscape appears as a plateau broken by many rounded hills and thousands of lakes and swamps. Except near the Labrador coast where there are a few elevations of over 5,000 feet, the Shield is rarely less than 1,000 or more than 2,000 feet above sea level. Locally there are low hills rising two or three hundred feet above the general level of the land and a multitude of shallow depressions partly filled with water, but viewed broadly the Shield is a plateau or highland of moderate height and great uniformity.

The lakes are very numerous. One observer declares that "the country could be described as water with land between it". Many of the lakes are extremely irregular in outline and are crowded with rocky islands. They are connected with each other by short waterways having many rapids and falls up to 100 feet in height. The rivers do not follow a well-developed or regular pattern; some of the lakes have more than one outlet and the drainage as a whole is very haphazardly arranged. The soils are typically thin and on over half the area the solid granite and gneiss appear at the surface. In a number of places, chiefly depressions, the hard rock is mantled with thick layers of clay. Wherever the soils are adequate and the climate suitable, the Shield is covered with coniferous forests, except toward the north where Tundra types of vegetation predominate.

Geology

From the geological standpoint the Shield is a "planated base of a vast system of mountains which were built and destroyed before Cambrian time."[2] The early history is difficult for geologists to decipher, for the rocks are exceedingly complex because they have been subjected to all sorts of changes subsequent to their original formation. The base of the oldest rocks, those of the Keewatin period of Archeozoic time, has not been recog-

[2]Collins, *op. cit.*, p. 346.

nized for they have been invaded by younger igneous masses which have obliterated their lower sections; Keewatin rocks now exposed at the surface must have cooled off slowly beneath a great load of earth material, otherwise the coarse crystals characteristic of this granite could not have been formed. Extrusions of lava into the Keewatin and younger formations took place at different times and so the immense volumes of granite and gneiss which surround, invade and presumably underlie the Keewatin are of various ages—Huronian, Animikie, Keeweenawan, Athabaska, and Grenville.

The significant point of the geology to the economic geographer is that the various rock formations cooled slowly so that relatively large crystals of rock could be formed and the economic minerals could separate themselves from the rest of the molten material. After the cooling was completed the mountainous surface thousands of feet thick was eroded until the Region was eventually reduced to a condition of relatively low relief. This peneplanation was accomplished before the Cambrian or first period of the Paleozoic era. The detailed geological history of the Shield is a subject of great controversy among professional geologists and it seems safe only to say that after its early mountain building experience, the Shield had a relatively placid existence for millions of years while running water kept up its slow but unceasing work of erosion.

During the Pleistocene period of the Cenozoic, the Shield was occupied by ice sheets having two main centres, one east and the other west of Hudson Bay. These continental glaciers carried off the pre-existing soil which was mainly deposited, as already described, in the Prairies and the St. Lawrence Lowland. As the glaciers withdrew behind the height of land which divides the waters flowing into the St. Lawrence from those which run into Hudson Bay, a large amount of detritus was laid down in a lake in front of the retreating face of the glacier. In this way the

Clay Belt of Ontario and Quebec came into being. Other glacial material was left in smaller bodies of water along the margins of the ice-sheets. Elsewhere vast amounts of unconsolidated moraine was dropped by the glacier without being worked over and sorted by water and left on the basal rock in scattered patches each a few square miles in area. At present not more than half the surface of the Shield is covered with soil or loose glacial debris. On the remainder of the Region solid rock is exposed at the surface.

As the glaciers pushed their way slowly over the surface of the Shield they removed the outer weathered parts but did not excavate the solid rock beneath to any considerable depth. They wore down the hills, especially on the side facing the on-coming glaciers, so that they acquired a rounded or knob-like appearance. The glaciers also gouged out holes or depressions where the rock was relatively soft. After the glaciers retreated many of these depressions were partly filled with water which spilled over the surrounding rim of the bowl at its lowest point into an adjacent depression. Often the moraine left by the glacier blocked up the old drainage channels, forcing the rivers to seek new outlets. Altogether, the effect of the glacier was to leave a haphazard drainage system with many falls and rapids.

At the close of the glacial or Pleistocene period the Shield lay at a lower level than it is now, as shown by the presence of marine sands and beaches far inland from the west coast of Hudson Bay. The uplift of land since glacial time has amounted to hundreds of feet and is apparently still going on.

In the ancient rocks buried deep within the earth conditions were favourable for the formation of valuable minerals. These minerals have been exposed at the surface of the earth by centuries of erosion and can be explored with relative ease because the rocks are not continuously blanketed with soil. The lack of soil has restricted agriculture to a few locations in the former

beds of glacial lakes, although throughout a larger area the soil cover is adequate for forest growth wherever climate is suitable. The inequalities of the rock floor and the barriers of glacial drift have created innumerable lakes and waterfalls so that hydro-electric power is relatively easily generated. The forest cover, the abundance of water and the cool climate favour fur-bearing animals. The geology has determined the broad lines along which the chief economic activities of the Region—mining, agriculture, forestry, the generation of hydro-electricity and the fur trade—are carried on.

Climate

Although the Shield covers an enormous area, the chief features of its climate are everywhere the same—long severe winters and short warm summers.[8] The climate is naturally colder than that of more southerly areas due to its poleward location and the fact that a mass of cold air from the north tends to dominate the Region during the entire winter. The cyclonic storms which arise along the polar front do not give much relief from the cold except in the southern parts of the Shield. This is true because the path of the storms is chiefly along the Great Lakes and the St. Lawrence Valley. It is only occasionally that a cyclonic storm brings warmer air northward and a "spell" of warmer weather is interspersed between the steady, intense cold.

In the summer the interior land mass heats up as the sun makes its apparent journey northward. Heat derived from the sun's rays must be used first to neutralize the cold which has been stored in the ice, snow and frozen ground from the previous winter. Once the frozen surface of the earth is thawed out, the land heats up quickly, for by this time the sun is so far north and the hours of sunlight per day so long that the amount of solar heat received in a day is relatively great. Spring is delayed

[8]Koeppe, *op. cit.*, pp. 139-59.

but comes in a rush when it does arrive. The average summer temperature at Cochrane in the Clay Belt is about the same as at Montreal. Unfortunately the summer is short, the average length of the frost-free period being only 90 days at Cochrane and shorter than this farther north.

The rainfall varies from 20 to 40 inches over the Shield but in only a few sections does it exceed 30 inches. Yet because evaporation is low, there is never any danger of drought. Precipitation declines toward the north because the cyclonic storms are weaker there than in the south. In the Clay Belt snowfall averages about 80 inches per annum, equivalent to 8 inches of rainfall. Soon after falling the snow packs down as a result of its own weight and partial melting. Not more than two or three feet cover the ground at any one time.

The severity of the climate is naturally an insuperable obstacle to agriculture over most of the Shield though in southerly areas which are favoured by access to good markets and which have soils with adequate chemical constituents and physical properties, farming is making steady progress. The climate is a less serious handicap to mining. Even at Great Bear Lake, 28 miles south of the Arctic Circle, where the winter temperature has gone as low as 72 degrees Fahrenheit below zero, the climate does not interfere with winter operations. Exceptional care has to be taken with water mains and sewage pipes. The sub-surface is either hard rock or permanently frozen soil and the ordinary method of protecting pipes from freezing by burying them beneath the frost line is not feasible. Pipes are carried above ground and thoroughly insulated with asbestos covering. Another bothersome complication arising from the perpetually frozen sub-soil in the far north is that the buildings begin to sag soon after construction because the heat from the stoves thaws out the

ground on which they are built.[4] This difficulty is overcome by raising the buildings so that cold air can circulate underneath or by putting posts well down into the soil below the permanent frost line. Nevertheless, construction work does not suffer on account of the cold climate and in some respects it is even facilitated. Permanently frozen sub-soil does not occur until beyond about 54 degrees north latitude.

Nowhere in the Shield does the climate prevent human beings living a healthy vigorous life.[5] Although the winter is long and frequently colder than the coldest weather in Montreal, Toronto, and Winnipeg, the general average is not much lower. The climate does not lead to debility but it does increase costs. It is expensive to heat houses and other buildings, to bring in during the summer supplies of all kinds, including almost all the food, and store them for winter use and, finally, to haul out the chief products to distant markets. The climate puts a great strain on the transportation framework, not on the human frame.

Agriculture

In view of the general physiographic and climatic features of the Shield, it is not to be expected that agriculture will occupy a prominent position. Nevertheless, there is one large and several small regions of potential farm land and the number of occupied farms within the physiographic province is already in the neighbourhood of 30,000.

The large area, called the Clay Belt, reaches from about 75 miles west of Hearst, Ontario, to 130 miles east of the Ontario-Quebec boundary and has a width of about 40 to 50 miles on either side of the Canadian National Railway line through Coch-

[4]Mozley, A., "Frozen Ground in the Sub-Arctic Region", *Scottish Geographical Journal,* vol. 53, July, 1937, pp. 266-70; Leggett, R. F., "Construction North of 54", *Engineering Journal,* vol. 24, July, 1941, pp. 346-8.

[5]Finnie, R., *Canada Moves North* (New York: The Macmillan Company of Canada Limited, 1942), pp. 5-7.

rane.[6] The total area of the Clay Belt is about 70 million acres but only part of this is fit for agriculture. The area was formed by the deposition of gravel, sand and clay in the bed of the lake which formed in front of the Pleistocene glacier, after it had slowly retreated behind the height of land between the drainage systems of the Great Lakes and Hudson Bay. The smaller farming areas are located around Lake St. John,[7] Lake Temiskaming, Lake Nipissing and in the vicinity of Sudbury, Fort William, and Dryden in Ontario, and Wabowden in Manitoba. All these districts occupy the beds of lakes which have shrunk in size over the centuries. The shrinkage was caused by the lowering of the levels of the pre-existing bodies of water when the rivers draining them cut deeper channels for themselves into the St. Lawrence, the Great Lakes, or Hudson Bay. Among the smaller agricultural areas of the Shield there may also be included the north shore of Lake Huron and Manitoulin Island, even though geologically these two districts are outliers of the St. Lawrence Lowland and consist chiefly of sandy soils.

The Clay Belt and most of the "pockets" have substantially the same type of soil and climate. The soils[8] are mainly heavy clay dotted with small areas of muskeg, or black muck, as it is known locally. There are usually rocky outcrops, especially along the edges or contact zones with the Shield. A good deal of unproductive soil exists and even the clay is of only fair

[6]Goring, E. T., "Horticulture in Northern Ontario", *Scientific Agriculture,* vol. 19, October, 1938, pp. 110-6; Hills, G. A., "An Approach to Land Settlement Problems in Northern Ontario", *ibid.*, vol. 23, December, 1942, pp. 212-6; Lower, A. R. M., *Settlement and the Forest Frontier in Eastern Canada* (Toronto: The Macmillan Company of Canada Limited, 1936), *passim*; Randall, J. R., "Agriculture in the Great Clay Belt of Canada", *Scottish Geographical Journal,* vol. 56. January, 1940, pp. 314-7; Taylor, G., *Environment, Race, and Migration* (Toronto: University of Toronto Press, 1937), pp. 314-7.

[7]Dagenais, P., *op. cit.,* pp. 114-6, 120-2; Glendinning, R. M., "The Distribution of Population in the Lake St. John Lowland, Quebec," *Geographical Review,* vol. 24, April, 1934, pp. 232-7.

[8]Goring, *op. cit.*

quality. In its natural state the clay is covered with spruce, balsam, and poplar. The leaves from these trees, after they fall to the ground, do not disintegrate rapidly because the climate is so cold and damp that micro-organic activity is restricted. Hence the soils are deficient in decayed organic matter or humus though they have adequate inorganic elements like nitrogen, potash and phosphates. The clay is heavy, not naturally easy to work, and needs careful attention to bring it into a state of productivity. Often the ground is covered with sphagnum moss which in swampy areas may accumulate to thicknesses of hundreds of feet, creating a "muskeg". Even in fairly well-drained areas the moss may be two feet deep. This mat insulates the earth beneath from the heat of the sun and keeps the sub-surface layers of soil perpetually cold and damp.

Obviously the first problem of the area is to improve the quality of the soil. This involves removing the moss before cultivation. The easiest way of doing this is by burning. Unfortunately, besides consuming the moss, burning may also destroy all the potential supply of humus which is locked up in the soil in stumps and other slowly-decaying vegetation. If the humus is destroyed, the ground will be poor for agriculture. Sometimes, too, the fires get out of control. Usually burning is carried on in the late summer when the moss is driest. The fires are ordinarily extinguished by the autumn rains but if the rains do not come when anticipated, the fires may burn and smoulder deep in the ground where they are impossible to extinguish by hand methods. If a high wind should accompany the dry weather, the incipient fires may be fanned into a strong blaze which sweeps through the adjacent forests, devastating everything in their path. In 1938, near Fort Frances, Ontario, 17 lives were lost and 46,000 acres of land burnt over as a result of a single fire which originated from clearing operations.[9]

[9]*Report* (Toronto: Dept. of Lands and Forests, 1939).

Another problem in soil improvement is securing good drainage. Clay soils retain moisture and remain cold and inhospitable to plant growth much later in the spring than loam or sandy soil. In a Region where the growing season is already short this is a serious matter. In the Clay Belt and the "pockets" the natural drainage, the network of rivulets, creeks and rivers which nature provides, is more complete and regular in its pattern than in the Shield generally but, even so, it is not adequate for agriculture. The forests also retain a good deal of moisture about their roots throughout the year and the seepage of this into the cleared lands maintains a higher water-table and keeps the agricultural land damper and colder than would otherwise be the case. As more of the timber is removed from the cultivated land, the natural drainage may be expected to improve, but some artificial aids to drainage will be necessary. Sub-soil or tile drains of the type used in the Lowlands are too expensive for a pioneer community but open or surface ditches are reasonably satisfactory provided they are properly located to take advantage of the contours. They are relatively cheap and do not interfere unduly with the cultivation and harvesting of crops.

Finally, the soils need to be improved by working organic material such as straw, black muck or animal manure into the clay. In this way the soil is loosened up, the permeation of air and heat promoted, drainage facilitated and tilth improved. Some patches of soil which are too acidic can be made sweet by adding lime. Soils which are good chemically have to be put in physical condition so that they can be easily worked. With proper management somewhere between one-quarter and one-half of the total acreage of the Clay Belt has soils sufficiently fertile and tillable for agriculture under current prices. The proportion is probably higher in the pockets. In both cases the amount of land economically usable could be considerably increased by an addition to the supply of animal manures, an advance in our knowl-

edge of handling mediocre soils, and a rise in the price of farm products.

Agriculture is limited also by the shortness of the growing season which is only about 90 days long in the Clay Belt and a little more farther south. During the summer the number of hours of possible sunlight per day is large and the average temperature during the warmest months is about the same as at Montreal in the Lowlands. Yet during even the warmest days the temperature may drop sharply if the wind should shift to the north or northwest. The rainfall is ample for agriculture but a good deal of it comes in the early part of September and often an otherwise good crop cannot be harvested properly because of its wet condition. Occasionally a few weeks of bad weather during the summer will considerably reduce crop yields. Of course these variations in weather from year to year occur in all agricultural regions but they are more serious in the Clay Belt and the "pockets" because agriculture there is being conducted close to the climatic limits. A reduction in the total amount of rainfall, precipitation coming at the wrong time of year, a late spring, or a frost early in the autumn may reduce the conditions of growth below the minimum requirements. In the St. Lawrence Lowlands climatic variations of the same magnitude are less disastrous because there is a greater likelihood that the weather will still be satisfactory for plant growth and maturity. A change in the weather which may not matter much in the Lowlands is of critical importance in the Shield.

What effect the clearing of larger blocks of land will have on plant growth is still a matter of dispute. The history of settlement in the Lowlands seems to reveal that as the forests are removed, the production of crops is more certain due to a slight extension of the growing season, a reduction in the frost danger, and especially to an improvement in tilth through better drainage. The effect of clearing on vegetal growth is obviously limited. It

is impossible radically to alter the climate which is determined fundamentally by meteorological factors beyond human control.

Despite the theoretical limitations, agriculture is being slowly and steadily developed in such parts of the Shield as have favourable soils, but difficulty is constantly being experienced in getting suitable settlers. Pioneering has always required unusual amounts of industry, thrift, and stamina on the part of the settler, his wife and family. The "bright lights" of the city hold many people. The possibility of having to join the bread-line or go on urban relief is either ignored or considered preferable to the isolation and unending toil of a bush farm.

Settlement in the Shield is facilitated because a farmer can get a quick income from selling pulpwood from his land and thus has some revenue to tide himself over the hard early years. This has its dangers for the temptation is to "mine the forest" rather than cultivate the land. It is easy to cut the pulpwood off the farm, get the quick cash income, fail to clear and put under tillage an acreage of land large enough to support the family after the pulpwood is gone, and then move away. The cut-over land is soon covered with second growth which is often harder to remove than the original forest cover. Because no pulpwood of value remains on the land there is no economic crutch for another farmer. Hence settlement may be postponed indefinitely. Meanwhile the abandoned farm has interfered with the maintenance of roads and schools by the remaining settlers. The pulpwood miner, though he has made off with the quick riches of the district, is usually disgruntled and a poor advertisement for the area.

Although the governments of both Ontario and Quebec do all they can to eliminate the timber miner, so far they have succeeded only in cutting down his numbers to about 10 per cent of the incomers. In parts of Quebec the purchaser of virgin farm land is forbidden to cut or clear more than a certain

number of acres each year.[10] This is a complete reversal of all previous settlement policies where rapid clearing has invariably been encouraged.

Some of the settlements in Quebec take place under the auspices of the Catholic Church. This institution is deeply concerned over the movement of young men and women from the farms to the cities. It feels that in the urban centres its youth will be exposed to great temptations, lose contact with "Mother Church" and unwittingly give up their language and customs which have been so carefully preserved since the British conquest. The Church methodically works out plans for the settlement or, as it is more properly called, colonization of a new parish in the Lake St. John district or elsewhere in the Shield. Essentially a group attacks the bush under the spiritual, educational and, in practice, the business leadership of the curé. While an individual owns his own land and determines his own success or failure, there is a great deal of co-operation in the clearing of land, the erection of farm buildings, schools and churches, the building of roads and so on.[11]

Of course, co-operation is by no means lacking in pioneer communities being settled by English, Scandinavian, or mixed populations but the spirit of the community is not so well integrated, not so parochial religiously and culturally as in Quebec. A study[12] of Clay Belt farms shows a higher cost of land, a heavier mortgage indebtedness, a bigger gross income and higher expenses in Ontario than in Quebec but no marked differences in net income. Generally speaking, the French are more content to go slowly and to lead a simple life than their English compatriots.

[10]Kemp, H. S., "New Colonies in Old Quebec", *Economic Geography*, vol. 12, January, 1936, pp. 54-60.

[11]Lower, *op. cit.*, pp. 76-93; Page, A., "La Colonization dans le Province de Québec, depuis 1930", *Études Économiques*, vol. 7, 1937, pp. 365-409.

[12]Gosselin, A., and Boucher, G. P., "Some Aspects of Land Settlement in Northwestern Quebec and Northeastern Ontario", *Economic Annalist*, August, 1939, pp. 56-61.

The development of agriculture in the Shield has undoubtedly been favoured by the existence of nearby markets in lumber camps, newsprint manufacturing centres and mining towns. Propinquity has been most important in perishable products, particularly whole milk and cream. The chief field crops raised are hay, oats, and barley. These form the basis of a steadily expanding dairy industry. The long winters make the raising of beef cattle costly and meat, along with fruit, early vegetables and flour is imported into the Shield. Climate prohibits the growth of wheat and such tender vegetables as cucumbers, tomatoes and sweet corn. Root crops like turnips, beets, and potatoes, and berries of all kinds grow in abundance. These products mature a little later in the Shield than in the Lowlands to the south. Farmers lose the early market and hence the highest prices in the cities but are somewhat compensated, in the case of berries, by being able to sell fresh fruit in the late market in Toronto and Montreal. Blueberries grow wild in the swamps and sandy moors. Some of the swamps have been cleared and blueberries are beginning to be cultivated like any other small fruit and shipped south, even to New York and Chicago. Tree fruits are not successful due to the coldness of the winters and the heavy, poorly-drained soils.

To sum up, agriculture in the Canadian Shield is conducted under obvious difficulties of climate, soils, and the cost of clearing land. The possibility of selling pulpwood in the early years or working in the woods, mills and mines during the slack season on the farm is a partial offset to these disabilities. Despite the operations of the timber pirate and the low prices of agricultural products, the acreage under cultivation was slowly extended in the 1930's. Farmers in areas settled for several years improved their land, buildings and livestock and acquired more and more of the attributes of prosperity. It must be emphasized again that the agriculture of the Shield is "spotty". "Most of the Shield

is rock and much of what is not rock is muskeg". Substantial development has been confined to parts of the Clay Belt and "pockets" of fertile soil. The difficulty of agriculture over the Shield as a whole is shown by the fact that the Frontenac axis north of Lake Ontario has a sparse and poverty-stricken population although it has been "under attack" by farmers for 80 years. The development since 1920 about Lake St. John, North Bay and Cochrane gives hope of better things in selected areas.

Forestry

Most of the Laurentian Shield was originally covered with forest. Toward the south in the upper Ottawa Valley, pine formed the basis of the early trade in square timber and in "deals" (three-inch planks) for export to Britain. Farther north these species fade out and a mixture of black and white spruce, balsam fir, tamarac and jack-pine covers almost all the land except rocky ridges. These resources form the basis of the pulp and paper industry. As one proceeds still farther north, jack-pine and poplar predominate, the size of trees diminishes somewhat, and the forests are confined to the river valleys, which are better drained and somewhat protected from the inclement weather. Still farther poleward the Tundra type of vegetation prevails.

The economic problems in connection with the forests of the Shield are concerned with methods of exploitation, the pulp and paper industry, conservation, and the relationship of forestry and settlement. The methods of logging are substantially the same in the Shield as in New Brunswick, since physiographic and climate conditions are similar. Most of the forest resources of the Shield are used for pulp and paper rather than lumber for construction. Shield lumber is too small in size and weak in structure to compete with high-quality timber of the Cordillera Region brought in by rail to the Prairies or by water to the St.

Lawrence Valley. Neither can it compete with locally-produced hardwoods in the Lowlands. Fortunately, it can be made into high-grade newsprint or cellulose because it is easily broken down by mechanical or chemical action, has a low content of resin, and is readily bleached.

Though the character of the wood is important in localizing the newsprint industry in the Shield, there are other advantages as well.[18] Hydro-electric power is cheap and abundant. This is important, since to produce a ton of newsprint per day requires from 60 to 80 horse-power. An enormous market for newsprint exists in the nearby cities of the most thickly settled sections of both Canada and the United States. In peacetime this market was steadily growing with the rise in literacy, the greater interest in sports, the increased amount of advertising and the voluminous Sunday supplements. By 1920 the easily accessible supplies of softwoods in the northeastern section of the United States were exhausted. American mills found it advisable to move to Canada because their chief raw material was bulky and of low value, whereas the finished article, being more concentrated and of higher value, could stand the heavier freight rates to market. In addition, most of the provinces of Canada have placed embargoes on the export of pulpwood from unalienated or crown lands, that is, from the areas to which title is still held by the public. Pulpwood is still exported from Canada but it comes from privately-owned lands or, under special permit, from crown lands. The ostensible purpose for the embargo was to conserve

[18]Bladen, V. W., *An Introduction to Political Economy* (Toronto: University of Toronto Press, 1941), pp. 145-87; Fell, C. P., "The Newsprint Industry", in Innis, H. A., and Plumptre, A. F. W., *The Canadian Economy and Its Problems* (Toronto: Canadian Institute of International Affairs, 1934), pp. 40-53; Guthrie, J. A., *The Newsprint Paper Industry in Canada* (Cambridge: Harvard University Press, 1941); Lower, *op. cit.*, pp. 21-7, 113-29; Minville, E., *op. cit.*, pp. 153-86; *The Lumber Industry* (Ottawa: Dominion Bureau of Statistics) annual; Ontario, *Report of the Select Committee appointed to Investigate . . . the Department of Lands and Forests* (Toronto: 1941).

a valuable and exhaustible raw material but the real reason was to force the manufacture of pulpwood within the Dominion. The effect of the embargo has been the same as a protective tariff in that it has led to the establishment within Canada of factories which otherwise might have been set up in a foreign country.

The province assisted development by granting the companies licences to cut timber from public lands in return for annual payments which vary, in large measure, with the amount of timber cut. These contracts or "concessions" allow newsprint manufacturers to begin operations without spending large sums on the outright purchase of timbered land. Because the payments for wood vary to some extent with output, a cyclical decline in production means a corresponding reduction in at least some of the expenses, thus giving a certain amount of flexibility in costs. In brief, newsprint manufacturing is located in Canada partly as a result of natural factors—large, cheap supplies of suitable wood and hydro-electric power, and easy access to a nearby expanding market—and partly because of artificial features like the embargo and the right to lease timber limits on payments fluctuating with volume of output.

Newsprint mills are located at the intersections of railway lines and large rivers either at the edge of the Shield as at Trois Rivières and Hull or in the interior as at Kapuskasing. The railway brings in mill supplies, food for the workers, and the relatively small amounts of pulpwood cut from their lands by nearby pioneer farmers. It also hauls out the finished product to consuming centres. The river brings down the logs. "The biggest variable in newsprint mills is the cost of transporting the wood from the stump to the mill. . . . In the original selection of a mill site and the assembling of its timber supply, the fate of a mill is to some extent pre-ordained."

Besides being used to transport the logs, water is needed to

generate power and in the manufacturing process itself. Hydro-electric power is required to chip or, with some methods of manufacture, to dessicate the wood. Heat generated by electricity is used to boil the ground-up pulp in the "digesters", where it disintegrates still further. Both heat and power are put to use in operating the huge Fourdrinier machines which receive a thin layer of water and pulp on an endless belt or mat made of felt. As the belt moves along, it is heated and the water evaporated. The liquid with its fine pulpwood is dried, rolled and finally emerges from the other end of the machine as finished newsprint. Obviously large amounts of power and water are needed in newsprint production and therefore the mill must be located on a large river near an important power site.

The size of each mill is limited by the amount of pulpwood with which it can be continuously supplied from its own particular drainage basin. If too large a mill is built, it will have to close down when it uses up the logs in its own basin. Its only alternative is to haul logs relatively long distances by rail from lands which naturally drain elsewhere. Rail transportation of the bulky logs is expensive in comparison with the cost of floating them down a river to a mill. Hence the unit of economic development is necessarily the drainage basin of an important river. If the mill is to be permanent, its annual requirement for raw material should be no greater than the annual increment of pulpwood through growth within its drainage basin. Each year the plant should cut only a certain number of acres so that when all the land has been cut over once, the second growth on the area in the first year of operation has grown to such a size that it will supply the raw material for another year. In the following year, the district originally cut in the second year of operations will be logged again. If this plan is followed, the mill will be in a position to operate continuously on the same location, provided it is able to keep its equipment at the proper state of

efficiency and its costs sufficiently low to meet the competition of new plants.

The governments of Manitoba, Saskatchewan, and chiefly Ontario and Quebec control substantially all the forested land in the Canadian Shield because little of it, except farm land, has been alienated. The provinces try to see that the interests of the newsprint industry and of the public are both protected. In particular they are anxious that each mill be permanent. Closing a mill due to lack of raw materials throws the former employees on public relief, cuts off a market for pulpwood by nearby farmers, results in financial losses to investors, and reduces provincial revenues through non-payment of "crown dues". Further, if each mill properly conserves resources, the problem of conservation for the whole industry is solved.

Although the theory of economic planning for newsprint is well understood, it is doubtful if it is being followed in practice. For example, in 1937 the Ontario government gave the Lake Sulphite Company[14] the right to cut all the spruce and balsam timber from a certain berth or limit or concession 3,400 square miles in area. In return the Company undertook to construct and operate a mill and pay an annual charge of one cent an acre for fire protection. As the lumber is cut, the Company must pay crown dues to the province amounting to from $1.50 to $2.50 per thousand board feet, depending on the quality of the timber.

The Company had the right to cut about 225,000 tons of pulpwood per annum. The annual increment through growth was calculated to be, for this berth, 200,000 tons a year. On the face of it, the mill has not adequate reserves to continue operations indefinitely but it is sometimes argued that the rate of exploitation is not fast enough, that trees already mature are beginning to decay and unless they are used quickly they will

[14]Ontario, *Report* (Toronto: Dept. of Lands and Forests, 1938), pp. 69-80.

become worthless. On the contrary, it can be contended that mature trees will keep in merchantable condition for many years. Their wealth is stored "on the stump" by nature until required by man and so there is no need to hurry development. The rate of cutting authorized on this limit by the government will use up the total resources of the area over a period of 35 years whereas timber now being cut has taken about 70 years to reach its present size. Of course, the second cutting of timber will not all be from seedlings which took root immediately after the first cutting but from saplings of several years' growth which have been left behind after logging. Be that as it may, a comparison of the present age of merchantable trees with the period of exploitation would seem to indicate over-cutting.

At the same time recent research has shown that past estimates of the rate of growth have been too low. The mill will not likely operate at maximum capacity during its entire life, since at times consumption will fall off due to fluctuations in the business cycle. Improved measures of fire protection may reduce loss from this cause below the figures calculated. There may conceivably be improvements in lumbering techniques, which will allow a large percentage of spruce and even of the poorer types of trees like jack-pine now left in the woods to be used in the manufacture of paper. In short, the whole matter is permeated with unknown quantities. No one can be sure until a great many years have passed whether each mill has adequate supplies of wood in its immediate vicinity or not. Certainly it is in the long-run interests of the mills themselves that they guard against depletion and the governments have almost as large a stake as the mills in permanency of operation. Yet with the best will in the world neither party can be sure of its position.

However badly or properly the provinces may have handled the problem of permanency of the mills, they were seriously at

fault in not seeing that the total number of mills established was not in excess of market demands. This could have been readily checked because promoters of newsprint plants had to come to the governments to get the right to cut timber from crown lands. During the boom decade of the 1920's Ontario and Quebec were carried away by the "new era" psychology of the time and by economic and political rivalries of long standing. The two provinces actually competed with each other for new mills. During the lean years of the 1930's demand declined, prices fell and mills were closed. There was unemployment in the mills and woods. Governments themselves suffered financially in so far as they had to pay relief to unemployed workers and received little revenue from crown dues.

In permitting the establishment of new mills the provinces should also have insisted that the new concerns have reasonably sound financial structures. A small mill, one with a daily output of 100 tons of newsprint, along with the necessary hydro-electric facilities, will cost five million dollars. This sum is not as large as would have been necessary if the provinces required mills to purchase their pulpwood limits outright instead of leasing them the right to cut pulpwood off a certain area for a flexible fee. Even so, the investment is considerable. A few companies tried to reduce their capital expenditures by purchasing electric power from outside sources but they merely replaced interest charges on their own investment with annual payments for power which had to be made whether or not the power was used.

The money for the new plants was raised chiefly by the sale of bonds. By 1930 the Canadian newsprint industry could produce far more paper than the market could absorb at going prices and so the companies began to slash prices drastically. Prices fell to such an extent that the companies could not meet the interest payments on the excessively large bonded indebtedness and the annual charges for hydro-electricity. As a result, over

half the companies were forced into receivership and many innocent investors lost money. If, as a condition of leasing crown lands, the provinces had demanded that the companies raise most of their money by the sale of common stock, the decline in earnings would have involved merely a postponement of dividends on stock and the companies would have avoided being pushed into bankruptcy. The experience of the governments of Ontario and Quebec is significant to the economic geographer who is concerned with the wise use of resources. To an increasing extent wisdom in the use of resources involves "economic planning". The effort at planning the newsprint industry of the Shield was not conspicuous by its success.

The economic planning of each individual mill has a direct bearing on the problem of conservation. It is obvious that if each individual mill has adequate, but no more than enough timber, to keep itself continuously supplied, the total resource will be used to the maximum consistent with the necessity of preserving a supply for future generations. As already shown, the position of any one mill cannot be determined accurately. In any case, to consider the resource in total may be more accurate than to deal with it by mills, since it is likely that an under-estimate in one particular factor may be offset by a corresponding error in the opposite direction regarding some other item.

According to a recent authoritative estimate[15] there are in Canada about 781 million acres of forested land or 35 per cent of the total area. Over a third of this is in sub-arctic or sub-alpine temperature zones, on poorly drained muskegs, or on other unfavourable sites that preclude profitable utilization. Although the forests on these locations help to control the supply of water for hydro-electric power and furnish a habitat for wild life, they are unimportant as timber. Of the 493 million acres

[15] *Canada, 1943* (Ottawa: Dept. of Mines and Resources), p. 81.

physically capable of producing continuous crops of timber of sizes suitable for commercial purposes, less than 275 million are broadly considered as accessible under present conditions of transportation, logging technique, costs and prices.

The quantity of timber actually growing in Canada is probably more significant than the acreage of forests. The total stand of timber of merchantable size is about 313 billion cubic feet, of which nearly 70 per cent is considered accessible. Of the latter about one-quarter is large enough for saw material and the remainder is suitable for pulpwood, fuel-wood, posts, mining timber and so on. The accessible timber is being used up at a fairly rapid rate. In the ten depression years, 1930-9, the average annual cut was two and a half billion cubic feet About 400 million cubic feet was destroyed by fire and 700 million ruined by fungus and insects. The total depletion amounted to 3,600 million cubic feet or about 14 cubic feet per accessible acre. But forests are capable of reproduction and growth. Unless growth per accessible acre proceeds at the same rate as depletion per acre, the resource will be exhausted sooner or later. It is by no means certain that the rate of growth over the accessible acreage does actually reach 14 cubic feet per acre but apparently increment and depletion were roughly in balance during the 1930's. If losses by fire, fungus, and insects could be reduced, and if the cut-over land were always effectively re-forested, the rate of growth necessary to the maintenance of the forest industries on the 1930-9 scale could not only be achieved but exceeded.

These estimates are subject to numerous qualifications, particularly as to the rate of growth and the loss by fire. They relate to Canada as a whole and do not consider the exhaustion of certain species such as Douglas fir or of forests close to consumers like the fuel on parts of the Prairies and the hardwoods in the Lowlands. Then too, the figures for the annual cut are those

for a decade of poor business years when the cut was more than a third lower than in boom times. As the forests are pushed back the cost of transportation will rise and the price may go up. This may stimulate the more intensive use of nearby areas. On the contrary, it may encourage the use of substitutes for lumber such as steel, concrete, stucco, asphalt (shingles). This shift will not affect pulpwood but the Shield faces another more acute danger, the substitution of southern pine for Canadian newsprint. Large supplies of pine are already available in the southern states and competition may be serious once the problem of eliminating the resin, heretofore the limiting factor in using it for newsprint, has been completely solved. Mills in the south would have the advantage that due to climatic conditions the pine attains a size large enough for manufacture in about half the time taken by Canadian spruce. It is conceivable that in twenty-five years the pulp and paper industry will be worrying more about selling its output than about exhausting its supply of raw materials.

Assuming, however, that the newsprint industry is going to be permanent, the first problem in conservation is the control of fire. During the period 1930-9 the fire loss was equal to 15 per cent of the cut for commercial purposes. Besides this direct loss fire usually consumes what little humus is in the soil and makes the land unsuitable for agricultural and occasionally even for forest purposes. On poor-quality, fire-swept soils birch and poplar, both low-grade woods, are more likely to grow than pine and spruce. Sometimes fire completely prevents reforestation, by destroying the seed trees. Burnt-over lands are harder to clear than forested lands and do not allow an incoming settler any pulpwood to provide himself with a quick cash income during his first few years of occupancy. Fires thus delay settlement instead of promoting it as might be supposed. Burnt-over lands also give little protection to fur-bearing animals so reduc-

ing the value of another resource. Finally, they are an unsightly blot on the landscape.

Protection of forests against fire is often pictured in a romantic light. In fact, it is a strenuous business requiring many trained men and much technical information.[16] Fires are detected from aeroplanes or lookout towers and are reported at once by telephone or short-wave radio to a district headquarters which distributes men and fire fighting apparatus to the most serious danger zones. Fires must be put out before they become large and beyond control. No attempt is made to extinguish every fire because this would involve too much expense. The forester considers that there is always so much "allowable burn" (1 or 2 per cent of the stand of timber in the area). These fires are put out by rainfall or other natural causes. When a fire shows signs of going beyond that percentage, speedy action must be taken. Fires are extinguished by covering with earth, spraying with water, clearing wide trenches or fire-breaks ahead of the fire and, occasionally, if there is little wind, starting a backfire. Shovels, portable pumps and lengths of hose as well as men and their food must be carried to the fire by railway, road or canoe.

Basic to all these efforts is the attempt to stop fires from starting in the first place. Experience has shown that many fires are started by smokers carelessly throwing away burning cigarettes and matches or not thoroughly extinguishing camp fires. Education is slowly reducing the number of these fires. Devices have been perfected for measuring the fire hazard, which is greatest when the forests are dry and the humidity is low. If the fire hazard is too great, an area may have to be closed to tourists. Sometimes fires start near where lumbering operations are being carried on. When a newsprint manufacturing company has the

[16]Brown, N. C., *A General Introduction to Forestry* (New York: John Wiley & Sons, 1935), pp. 61-90; Hawley, R. C., *Forest Protection* (New York: John Wiley & Sons, 1937).

exclusive right to the forest resources in a drainage basin for a long period of years it is to its own interest as well as those of the public to prevent devastating fires. The number of forest fires started as a result of clearing operations is not large but such fires are often disastrous since agricultural areas are outside the jurisdiction of the forest protection service and prompt action may not be taken in combating them.

The value of the forests is also being steadily reduced by the activities of noxious insects.[17] Sometimes these insects actually kill the trees. More often they merely slow down the rate of growth and render the maturing trees unfit for profitable utilization or else damage stored stock. Infected trees are commonly more susceptible to fire than healthy ones. The loss of wealth from all these factors is very great. The larch saw-fly destroyed most of the larch in Eastern Canada many years ago and the spruce bud-worm ruined 200,000,000 cords of spruce and hemlock. In 1930 the European spruce saw-fly was discovered in 2,000 square miles in the Gaspé peninsula. By 1938 it had badly infected 12,000 square miles and was known to be present in greater or lesser numbers as far west as Sudbury and south to New Jersey. The main natural controls on the activity of this insect are mice and shrews. These eat the cocoons in which the larvae winter under the forest floor. There are many other species of noxious insects and the Dominion government has spent considerable money in trying to limit their depredations. Diseased trees are sometimes removed. Attempts are made to salvage and use affected timber. More especially parasites are brought in from other areas and bred in the laboratory. If the parasites will destroy harmful insects without becoming pests in themselves they are liberated. Unfortunately, the discovery of

[17]de Gryse, J. J., "Noxious Forest Insects and their Control", *Canada Year Book, 1939,* pp. 254-63; Hoffing, G. R., "Insect Damage", in Mulholland, *op. cit.,* pp. 62-6.

suitable parasites is a slow process and great damage often results before the pests are discovered and brought under control. As one pest is successfully combated, another may become more virulent and so the task of subjugating the forest pests is never complete.

Once the timber has been removed from an area either by commercial logging or by fire and disease, the matter of reforestation[18] becomes vital. Many popular discussions of this problem make invidious comparisons between North American and European forest management without realizing that conditions on the two continents are markedly different. Europe is densely populated. The supply of lumber relative to the demand is small and the price is comparatively high. Labour for working in the forests is cheap. The need for being self-sufficient in time of war colours popular thinking. Consequently European forests are tended carefully. Only the mature trees are removed and young trees are allowed to remain so that the forests will produce a continuous crop of high-quality timber. Sometimes the young growth is thinned out and trees trimmed of surplus branches in order to produce the maximum amount of lumber per acre. The average annual increment on European forests is about 28 cubic feet or twice the Canadian average. A slightly better climate for tree growth as well as forest management may be responsible for the remarkable difference.

In North America forestry is carried on against a different background. Supplies of wood are certainly not inexhaustible but they are still ample. Labour is dear and can be more profitably used for other purposes than raising a "crop" like lumber which, in view of the long time it takes to mature, has a low annual yield per acre. Logging of only mature trees

[18]Ely, R. T. and Wehrwein, G. S., *Land Economics* (New York: The Macmillan Company, 1940), pp. 271-34; Craig, R. D., "The Social Implications of Economic Progress", *Proceedings of the International Conference of Agricultural Economists* (London: 1939), pp. 102-10.

in a stand is too expensive, except in the Lowlands, where conditions begin to approach those of Europe as far as density of population is concerned. Selective logging increases costs because the yield per acre declines, the equipment is used less intensively and the charges for hauling a given volume of lumber or pulpwood to the mill increase when a large number of acres has to be scoured to get it.

Modern forestry in North America is based on cheap supplies of lumber obtainable by clear cutting. Most of the area of the Shield now covered with mature timber seems to have been swept clean 75 to 80 years ago by a particularly widespread and destructive fire. The trees which started their growth just after that fire have now reached maturity. Instead of a normal age distribution of trees—seedlings, very young trees, rapidly growing, mature, and decaying trees—most of the growth is of about the same age and is now ready for cutting. From the standpoint both of cost and age distribution clear cutting is justified. Moreover, it is not necessarily inconsistent with continuous yield. If each year the mill clear-cuts only so much land that by the time all the land has been cut over once, the trees which have grown up on the section cut in the first year will have attained a size large enough for use; and if this plan is followed year after year, then the berth or limit will yield a continuous crop with the sections being cut in rotation.

It is obvious that clear cutting and rotational logging can be practised only if the sections reforest themselves properly. The danger is that re-seeding may be delayed or that inferior species grow. Under most of the agreements with the provinces, the newsprint company is to cut and remove the jack-pine trees at the same time as the adjacent spruce is cut. In this way the seed of the poorer species is no more plentiful than the seed of better varieties like spruce. Except about camps, tote roads and railways, slash is not burned. This practice differs from that in

British Columbia but it has been found in the Shield that it is better to take the chance on having a big fire which may be rendered worse by the presence of slash than to have several small fires from slash burning. Even under strict control, slash burning reduces the humus content of the soil, dries out the seed-bed and takes away the natural protection to the growing seedlings.

The area of propagation of a spruce tree is a circle of about 500 feet radius, since the wind cannot easily carry the seed beyond this distance. Under the concessions the government has the right to require that the companies leave any suitable seed trees. Isolated seed trees are likely to be blown over by the wind (since coniferous trees are typically shallow rooted) before they can complete their work of seeding. Hence a clump or copse is sometimes left. More frequently loggers just take a chance on enough seedlings and seeds remaining after cutting, to regenerate the stand. The majority of the Committee of the Legislature investigating timber resources in Ontario concluded that "so long as proper conservation methods are employed, such as regulation of cutting, fire protection and combating insect destruction, there is no need for large-scale [artificial] reforestation."[19]

Some of the features of the inter-relationships of forestry and agriculture have already been dealt with incidentally in other connections. The opportunity to sell timber[20] off his land or work in the lumber camps or mills during the winter gives the farmer a chance to earn something in cash while clearing his land, and paying for his livestock and a few implements. The danger is that instead of regarding income from the sale of pulpwood or from outside work as a temporary expedient, the farmer will come to consider them as permanent. If he does so, the operation of the farm is left to the women and school children. Usually

[19]Ontario, Report of the Select Committee, *op. cit.*, p. 29.
[20]Ely, *supra*; Lower, *op. cit.*, pp. 76-112, 130-46.

the farm degenerates and never becomes a paying proposition. Settlement may be indefinitely retarded but if the farm should become well established, the logging camps and mill towns will provide a good nearby market for agricultural products.

Aside from the problem faced by individual farmers, there does not appear to be any irreconcilable conflict between farming and the wood-using industries. At one time when lumber was logged off land, it was expected that the farmer would follow immediately. Sometimes he did not come for many years. In the meantime trees and bushes grew up and this second growth, though usually valueless for saw-timber or pulpwood, was more difficult and expensive to clear than the original forest. Even when he had cleared the land, the farmer often found that the soil was infertile, the climate unsuitable for agriculture, or the land poorly located with respect to markets. Often these inhospitable conditions forced the farmer off the land or else he remained to eke out a precarious existence. The farmer had wasted years of toil and his investment. The logger lost the good-quality timber which might have been growing on the land. Society suffered from having derelict citizens on its hands.

The fundamental difficulty was that no agency determined in advance and on an intelligent basis whether the land was to be used for lumbering or for farming. The mistakes of the past are only too evident in the Frontenac axis which was logged over many years ago. To avoid the same troubles in the parts of the Shield which are now being logged, it is assumed that all the land will be permanently used for growing timber or pulpwood. The lumberman must leave the land in such a condition after logging that high-grade trees will grow as quickly as possible. No land is thrown open to settlement until competent farmers are likely to be more or less immediately available to clear and farm the land. Neither is settlement permitted unless the area will sustain a prosperous rural community, in the opinion of

qualified officials who have studied the soil, climate and access to markets of each area. Scientific evaluation of settlement possibilities followed by careful selection of settlers does not guarantee that mistakes in settlement will not be made either by individuals or by the government but it does mean that the seriousness of such errors will be minimized. Incidentally, newsprint companies are sometimes in favour of moderate farming development near their concessions. These settlements will provide the company with a good work force in the mills and camps during the winter, the right to purchase pulpwood from outside their concessions while conserving their own resources, and a nearby supply of some farm produce for their employees.

To sum up, the use of the forest wealth of the Shield is attended by several difficult problems. Because the provincial governments control the crown lands from which most of the pulpwood is cut, they have had the opportunity of planning the development of the industry on a sound basis. This involves the proper location of mills, restricting the number of mills so that they can regularly operate at a reasonable profit, and insuring a sound financial structure for each mill. Most important of all, planning involves the complicated question of conservation in all its aspects—rate of use, control of fire, insect pests and disease, and especially reforestation. Finally, there is the problem of the inter-connection of forestry and agriculture. How well all these problems are being met can be determined only after many years' experience.

The pulp and paper industry is one of the leading manufacturing industries in Canada, having been first in wages and salaries since 1922, first in capital for some years, and second only to non-ferrous smelting and refining in gross value of output. Of course, newsprint is manufactured in British Columbia, Nova Scotia and New Brunswick as well as the Shield but over 80 per cent of Canada's output is made either on the edges of the

Shield or in the St. Lawrence Lowlands from Shield pulpwood. Canada as a whole normally produces nearly 40 per cent of the world's newsprint and 90 per cent of the output is exported, chiefly to the United States though some goes to many other nations also. About half the paper consumed in the United States is either of Canadian manufacture or is made from wood or wood-pulp imported from Canada.

Mining

The mineral resources of the Canadian Shield are varied and extensive. New mines are constantly being opened up and older, unprofitable ones abandoned. Any description of the location of all of the mines would quickly become out of date. Accordingly, only the chief centres of production will be described here but the uses of the minerals and the economic problems connected with mining will be explained in some detail.

The earth's crust is composed of 92 elements. These have combined to form minerals, one or more of which when combined in more or less regular proportions over appreciable parts of the earth's crust is called a rock.[21] Most of these rocks like quartzite, diabase, and syenite are of little economic value to man. However, most of the elements such as iron and gold, and some of the combinations of elements or minerals such as potash (K_2O) and soda (Na_2O) are of commercial value. Rocks from which elements or minerals can be obtained at a profit are called ores. This definition of ores has remained unchanged in meaning throughout the centuries but it is continually changing in its application. Rocks at one time considered valueless are brought into the category of ores by the discovery of new uses for minerals, by reductions in the cost of extracting minerals from ores, and by the exhaustion of previously used, higher-grade ores, and so

[21]MacLean, A., *Geology for the Layman* (Toronto: Northern Miner Press, 1939).

on. In short, what rocks are ores and what ones are not varies from time to time.

Of the 92 elements in the earth's crust, eight—oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium—make up 98 per cent of the volume and the remaining 84 elements form only two per cent of the whole mass. If all the elements were spread evenly throughout the crust it would be virtually impossible for us to secure such important minerals as lead, zinc, and tin. Minerals must somehow or other be concentrated into ores in order to be of commercial value.

Concentration takes place in a variety of ways.[22] Lava which is emitted by volcanoes flows over the surface of other rock formations. Other molten material is intruded into the rocks from underground sources. All this igneous matter is composed of a number of different elements, each one of which is in a molten or liquid state. Now elements change from liquids to solids at different temperatures just as water, a liquid, forms ice, a solid, at 32 degrees Fahrenheit, and iron becomes malleable at about 400 degrees, and so forth. When lava begins to cool from its initial temperature of perhaps 1,000 degrees, the element with the highest temperature for solidification starts to form at the outside of the mass, since the temperature is lower there. The solidification of this mineral, say quartz, will leave less quartz in the interior of the mass. Hence there is a tendency for the quartz to migrate toward the borders of the mass. When the temperature has declined to the point where some other element begins to change to solid form, the other mineral will tend to migrate to the zone next the quartz. In this way minerals will be deposited in concentric shells—quartz, then barite, mercury, antimony, gold, silver, lead, zinc, copper, bismuth, arsenic, tungsten, and tin.

[22]Bruce, E. L., *Mineral Deposits of the Canadian Shield* (Toronto: The Macmillan Company of Canada Limited, 1933), pp. 8-60.

It is obvious that rings of minerals cannot be formed in this way if the original magma did not contain them in their liquid form. There will doubtless be overlapping of the mineral zones and the process must go on slowly. If the magma cools very quickly, as is the case when it is extruded at the surface of the earth, the temperature falls so suddenly that all the minerals solidify at one time. They are literally frozen (solidified) where they stand. Thus the rock, though it might contain a number of valuable minerals, would have them so widely scattered that it would not be profitable to incur the expense of extracting them. Since, as we have seen, the Shield at one time consisted of high mountains into which the magma intruded, cooling necessarily took place slowly in the depths beneath the thick overlying mass. In this way minerals were concentrated in rings and these have been exposed at the present surface of the earth by the erosion of the overlying rocks. Needless to say, the pattern of concentric rings rarely approaches perfection, because of the subsequent intrusion of other masses, the complete erosion of some of the rings, etc.

Other ores have been formed by the squeezing out of liquid portions of the magma under pressure due to movements of the earth's crust. The liquid may invade cracks and joints in surrounding rocks and, upon solidification, form valuable ores. Sometimes chemical reactions take place between the ore solutions and the walls of the channels along which they pass. For example, gold may be held in solution by sodium and potassium carbonate but if these carbonates are removed by forming new chemical compounds with elements in the adjacent rocks, the gold will be left behind. In addition to these methods minerals are formed in a number of other different ways. Unfortunately for mankind, the conditions giving rise to minerals of economic value have occurred but rarely throughout the course of the world's geological history. The result is that ores are "abnormal

and somewhat rare" when the total volume of the rocks of the earth is considered. Geological conditions in the Shield have, on the whole, been favourable for mineral formation.

The most important single mineral produced in the Shield is undoubtedly gold.[23] This metal has always fascinated men because of its lustre, malleability and comparative scarcity. It is used in dentistry, jewellery, and as a reserve for paper money. Governments fix the price and undertake to buy all the gold produced and so there is no marketing problem. None the less, the miner may suffer from the swings of the business cycle. His output, though it may be unchanged in terms of dollars, will purchase a smaller quantity of goods and services due to the rise in prices. Also his profits may be less because the cost of labour and of supplies may increase while the selling price of his product, gold, remains the same as before. Thus gold mining is not immune to changes in price.

In Canada gold is found in alluvial sands (placer mining) or in veins or lodes (hard-rock mining). Placer gold was formed by the erosion of auriferous rocks and the subsequent transportation of the fragments by water. Because gold is a relatively heavy metal, it soon sank to the bottom of the stream and was later covered with sand and gravel. Placer gold is comparatively easy to discover and exploit. The reserves are quickly exhausted and placer mining in Canada has steadily declined in importance.

Almost all the gold secured from the Shield has been obtained from hard rocks. Undoubtedly, in the millions of years before the glacial epoch, the agents of erosion tore nuggets of gold from the veins and scattered them along the beds of nearby streams. The Pleistocene glacier so widely scattered the sands with their valuable nuggets and gold dust that in only a few spots have the concentrations been rich enough to justify the expense of mining. The glacier, by removing the soil and partially decom-

[23]Bruce, *op. cit., passim*; Moore, E. S., *The Mineral Resources of Canada* (Toronto: The Ryerson Press, 1933), pp. 91-116.

posed rock from the surface, exposed the "mother lode" in a position where the gold could be easily discovered and extracted. Typically, gold occurs in the Shield in veins though in some of the most important mines it is in larger masses of highly mineralized rock, called lodes. In all cases the rocks are of ancient origin and have intruded into other formations while in a molten state and then cooled very slowly.

The most important gold-mining districts are located at Porcupine and Kirkland Lake in Ontario. One single mine, Lake Shore, the largest gold mine in North America, has produced $140,000,000 of gold since it came into production in 1918 and has paid $65,000,000 in dividends. Its reserves are adequate for many years to come but the vast majority of mines are small, produce only a few tens of thousands of dollars of gold and have a life of about fifteen years. In addition there are literally hundreds of "holes in the ground"—mines which were started but which never came into the producing stage because the gold content of the ore was not high enough to cover the cost of mining, or because the reserves of ore were too small, or because the promoters lacked the money to complete development, or for other reasons. In the Shield gold is also found in conjunction with other valuable minerals as well as by itself in rocks.

Before dealing with the other mineral products of the Shield, it is advisable to describe briefly the methods of securing gold-bearing ore from the earth and then separating the precious metal from the worthless rock (gangue) in which the metal is found.[24] Where a rich concentration of a metal is found at the surface it is possible to obtain it by pick and shovel, with a little gunpowder to loosen up the rock. This crude method was some-

[24]Jenkins, H. P., *Nova Scotia at Work* (Toronto: The Ryerson Press, 1938); McBride, W. G., "Mining Engineering", vol. 20, *Engineering Journal*, June, 1937, pp. 397-700; Redmayne, Sir R., "Mining and Power Development of Ontario and Quebec", *Bulletin of Imperial Institute*, vol. 26, 1928, pp. 39-60.

times followed in the early, exceptionally rich, "grass-root" silver mines in Cobalt. But soon a shaft had to be sunk and instead of trying to blast the ore upwards from the rock beneath, it became more economical to use the force of gravity to loosen the ore in so far as it was possible to do so.

Nowadays the practice is to sink a shaft or well vertically into the earth. At various depths several hundred feet apart a room or station is excavated and from it a tunnel or "cross-cut", about six feet wide and seven feet high, is driven horizontally through the rock. From time to time the cross-cut will—let us hope—intersect veins of gold- or silver-bearing rock which extend upward toward the surface of the ground and horizontally in opposite directions. Whenever a careful appraisal, or assay, of one of these veins indicates that it contains enough precious metal to cover the cost of mining, another horizontal tunnel, or "stope" or "drift", is pushed along in the direction followed by the vein. The drift is continued until the boundary of the property is reached or the vein "runs out" because its metallic content declines to the point where it is not worth while to mine. Ore is removed from the roof above the drift by stoping, that is, placing dynamite into holes made in the roof with pneumatic drills and then blasting down the rock. This rock is sent to the surface and then a very strong wooden platform is erected within the drift about seven feet up from its floor. Holes are again drilled in the roof. Another six or seven feet of rock is broken down, though in this case it falls on the wooden roof or lagging. Rock containing gold is shovelled along to holes in the lagging, where it drops through into cars which run on tracks laid along the drift and the cross-cut to the station. The vein containing the precious metal is probably so narrow that if only the gold-bearing ore were removed, a man would not have room to work. Also, it is virtually impossible to blast out only the metalliferous rock. Thus a good deal of rock containing no gold at all is

forced down onto the lagging from either side of the vein. After the valuable rock has been shovelled away, the worthless rock is allowed to remain on the lagging. It is covered with steel plates to aid in shovelling the rock which is forced down by the next blast. Broken rock takes up more space than solid rock and so it will likely be necessary to haul some of the rock to the surface where it is discarded, while the metal-bearing ore goes to the mill. In some cases the vein may be wide enough so that it pays to raise to the surface all the rock blown down by the blasting. In this case sand or worthless rock will have to be brought down from the surface to "back-fill" the stope.

At all events, the vein along the drift is blasted down from the ceiling. The rock containing metals is shovelled down chutes built through the lagging and falls into cars. In this way ore is got out of the mine with the minimum of human effort and with as much use as possible of the force of gravity. Moreover, the rock is partially shattered by its fall from the roof and so is partly prepared for the processes of extracting the mineral. Of course, the ore in the cars must be raised to the surface of the ground by elevators running in the vertical shaft. This is expensive but very much less so than if the ore had first to be blasted out from the floor rather than from the ceiling and then lifted up with hand shovels into the cars.

Once the gold-bearing ore is brought to the surface the gold must be separated from the gangue or valueless rock in which it is contained. In small mines the extraction begins by picking out by hand the pieces of rock containing deposits of metal and throwing away the remainder. The high-grade pieces are crushed in a stamp mill which is, essentially, a long iron box in which a battery of heavy blocks of iron, or stamps, regularly hammer down upon the rock with great force. The hard brittle rock is broken into bits but the gold is more malleable and is not shattered so easily. Moreover, gold is quite heavy. When a

strong current of water is directed through the end of the box in which the stamps operate, it tends to carry away the barren rock while the gold sinks to the bottom of the box. About every fortnight there is a "clean-up" when the gold along with particles of heavy rock is removed from the box. The contents of the box are then placed in a ball mill which is, in essence, a rotating barrel about one-third filled with iron balls. After rotating for several hours the gold-bearing rock is pulverized by continual rubbing against the hard, rough balls and the walls of the drum. Then mercury is poured into the mixture. It picks up the gold somewhat like blotting paper absorbs ink. The mixture is panned, sluiced around with water in a dish so that the worthless rock falls out over the side of the dish while the heavier mercury-gold is retained. The mercury-gold is then heated. The mercury vaporizes (forms "steam"), is condensed (solidified) when it returns to the ordinary temperature of the atmosphere and then is used again. The gold is poured into a mould where it sinks to the bottom while impurities rise to the top as slag.

However, stamp mills are relatively inefficient. They rarely recover much more than three-quarters of the gold which is theoretically present in the ore and mercury is expensive. They are now used chiefly to "prove up" a mine, to demonstrate whether or not the mineralized rocks in a property contain enough metal to cover the cost of mining and yield a profit.

In most established gold mines the cyanide process is used. The essential feature of this process is that the ore is ground into such fine particles that a solution of sodium cyanide, a strong acid, dissolves the gold from the gangue. The ore is broken down by crushers operating like huge jaws to "masticate" the rock. Then the ore is milled in rotating cylinders partly filled with balls, tubes or rods against which the rock tumbles and is pulverized. Cyanide solution which is added to the

broken down rock at this stage immediately begins to remove the gold from the gangue. Eventually the rock is milled to about the fineness of sand. The mixture of ore and cyanide solution is agitated with air for several hours in order that the cyanide may be able to attack chemically every particle of ore and dissolve whatever gold it may contain. The barren rock particles or tailings are not absorbed by the cyanide solution but are separated from it by filtering and then thrown away. The filtered solution of gold-cyanide is treated with a small amount of zinc dust which causes the gold to precipitate, or fall, in solid particles to the bottom. The precipitate is filtered out and refined to form a brick of gold. The cyanide solution is purified and used again. The advantages of the cyanide process are that practically all the gold—from 92 to 99 per cent of it—is segregated from the ore; the gold secured is 99 per cent fine: the process is continuous, automatic and it is cheaper than stamping, despite the very much higher capital cost of the plant required.

About 15 per cent of the gold output of Canada is obtained from ores which also contain copper, zinc and silver. In the Shield the two most important areas of these deposits are at Flinflon on the Saskatchewan-Manitoba boundary, and Rouyn and Noranda, adjacent towns 25 miles east of the Quebec-Ontario border. In both areas there are large reserves of ore and the mining camps are likely to be more permanent than most purely gold-mining centres except those at Porcupine and Kirkland Lake.

Since the ores at both Flinflon and Noranda contain many kinds of minerals the problem of separating them from the gangue and from each other was difficult. The problem defied solution for many years, until in 1923 the Consolidated Mining and Smelting Company at Trail perfected the flotation process[25]

[25]Cole, G. E., *The Mineral Resources of Manitoba* (Winnipeg: Manitoba Economic Survey Board, 1938).

for dealing with ores of a similar complex character. The ores are crushed and ground to very fine particles as in the cyanide process. The powdered ore is thoroughly mixed with water. Chemical re-agents, chiefly pine oil and cresylic acid, are added and then while the mixture is agitated in a huge drum, air is forced through the mixture in such a way that it bubbles up to the top where it forms a froth. As the finely-divided air bubbles rise to the surface they pick up the minerals from the gangue. In reality the bubbles float the minerals to the surface. The froth is then removed. The minerals are precipitated in another container and so made available for use. The valueless gangue does not attach itself to the bubbles and is discarded as waste or tailing at the end of the machine. The physical weight of the minerals is not the determining factor in flotation. Minerals like lead, which are two or three times as heavy as the gangue, may be floated away. By controlling the forced inflow of air and the chemical re-agents added to the wet pulverized ore, different minerals may be induced to adhere to the bubble or repel it as may be desired and so they can be separated from each other.

The flotation process is the key which has unlocked the mineral wealth of large sections of the Canadian Shield and southern British Columbia. It uses comparatively small amounts of labour and gives an almost complete recovery of metal from the ore. In copper mines it produces a high-grade matte or concentrate. Most important of all, flotation is selective. One mineral at a time can be floated away from the gangue and from other minerals. In this way very complex ores can be treated. Finally, if it does not pay to extract one mineral, say iron sulphide, under present prices the flotation process allows the mineral to be stored in the tailings until there is a demand for it.

Besides gold the Shield produces silver which is used in jewellery, cutlery, in coinage and as a reserve for paper money.

Unlike gold, its value is not determined by government order nor do governments undertake to purchase all the silver which is brought to them. The price of silver is determined by the ordinary conditions of supply and demand. Most of the world's silver is found in ores which also contain other minerals, especially copper, lead, zinc, and gold. The ore is mined chiefly for these other metals and silver is a by-product. The bulk of the costs of mining and milling the ores is borne by the other minerals and the silver is sold for any price it will bring. The price of silver has been permanently depressed and the persistently low prices have practically driven out of production mines which produce silver alone. At any rate, this has been the experience of the purely silver mines of the Shield though the mines where silver is a by-product such as Flinflon and Noranda continue to be important producers.

From 1904 to 1924 the amount of silver produced at Cobalt, South Lorrain, Gowganda and other points in the district west of Lake Temiskaming averaged nearly 18,000,000 ounces per annum. As a producer, the Cobalt district ranks after Potosi in Bolivia and two mines in Mexico, all of which have been worked since the middle of the sixteenth century. One mine near Cobalt paid dividends of $29,000,000 on an original capital of a quarter million. Since 1925 production has declined consistently because the more valuable argentiferous ores have been exhausted and it does not pay to use low-grade ores at the present price of silver.

In the Cobalt area the silver occurs in narrow, vertical veins running in all directions. The veins vary in length from a few feet to as much as 1,800 and may be 300 or more feet deep. It is believed that hot solutions issuing from a deep source forced their way into cracks in the overlying rocks. Then they cooled slowly beneath the deep rock cover which was subsequently stripped off by erosion. A modified flotation process

is now often used for the extraction of the metal though formerly with the very rich ores, simple stamp mills were employed.

Often other minerals—cobalt, nickel and arsenic—are associated with the veins of silver. The output of cobalt in this area was formerly very important. Because it has the property of destroying the yellow tints caused by iron, cobalt is used in the manufacture of pottery, enamels, glass and dyes. Cobalt steel is used in razor blades and permanent magnets. In recent years higher-grade cheaper cobalt ores from the Belgian Congo have tended to displace the Canadian product. Arsenic, a poisonous element, and very small quantities of nickel are also produced in the Cobalt district.

An exceedingly important mineral of the Shield is nickel. Canada produces about 88 per cent of the world's output. Almost all of the Canadian production comes from the vicinity of Sudbury. This mining area has "the appearance of a bowl 22 to 25 miles long and 10 to 12 miles wide filled with sediments and with ore bodies dipping inward though much complicated by faulting".[26] The thickness of the nickel ore formations at the surface is about 180 feet. This "is unquestionably the most nearly permanent metal mining camp in Canada and possibly in North America. Its future is apparently assured for another century at least".[27]

Nickel has a wide variety of uses. Two to three per cent nickel added to molten iron gives nickel-steel which has greater toughness and tensile strength than ordinary carbon steel. It is used in steel rails, bridges and armour plate. Nickel-silver which is really a composition of nickel, copper and zinc, is used in plating cutlery and automobile parts because it will not tarnish easily. Monel-metal is a patented alloy composed of nickel, copper

[26]Barton, T. F., "The Sudbury Area", *Annals, Association of American Geographers*, March, 1942, p. 102.

[27]Moore, *op. cit.*, p. 127.

and iron with small amounts of manganese. It is stronger than steel but can be easily rolled and resists corrosion. Also it is cheaply made because it is unnecessary completely to separate the nickel and copper of the ores from each other in order to manufacture it.

The Sudbury ores contain about 3.5 per cent nickel and 2 per cent copper on the average besides small amounts of gold, silver and the platinum group of metals. The ore, after being crushed and sorted, is roasted in heaters to drive off the sulphides. It is then smelted by means of coal or coke in a furnace. The resulting concentrate or matte contains from 20 to 35 per cent of nickel and copper. Further treatment by heat with air being blown through for 20 minutes increases the metallic content to nearly 80 per cent. The matte is shipped to a refinery at Port Colborne on the north shore of Lake Erie, where coal can be cheaply brought in by water from the United States. Refining involves smelting the matte with suitable fluxes to separate nickel oxide from copper. The nickel oxide is then broken down by electrolysis. As an electric current passes through the matte in a suitable bath of chemicals, nickel collects at one of the electrodes.

At Sudbury the sulphurous fumes given off during roasting destroy all plant life in the vicinity. To the loss of the nearby forests there must be added the waste of the sulphuric acid contained in the gas. If Ontario possessed deposits of phosphate rock, the sulphuric acid might be used to produce superphosphate, a very valuable fertilizer. Efforts have been made to recover the sulphuric acid for making sulphite pulp for newsprint and cellulose products but so far the price of acid is higher than that secured from the natural sulphur ore from Texas. "The loss of the gas is a great nuisance as well as a serious economic waste".[28]

Besides producing the bulk of the world's nickel, the Sudbury

[28] *Ibid.*, p. 130.

area supplies about 40 per cent of the world's platinum, palladium, rhodium and allied minerals. Canada is the largest producer of these metals though Russia is a close competitor. Sudbury also produces copper and some gold and silver. Within a radius of 22 miles of the city there are 6 active mines, 3 active smelters and 38 abandoned or inactive mines some of which contain large potential ore reserves.

That section of the Canadian Shield which lies south of Lake Superior produces high-grade iron ore in such large amounts that it supplies over 80 per cent of the huge United States demand. Naturally, Canadians hope that similar rich deposits may be found north of the Lake but so far their hopes have been only partially fulfilled. From 1900 to 1919 the Helen and Magpie mines, located in the Michipicoten district about 12 miles inland from Lake Superior and 120 miles north of Sault Ste. Marie, produced nearly five million tons of ore.[29] The ore was contained in "bowls" or basins. The largest of these was 1,100 feet long and 400 feet wide. It decreased in size until at about 700 feet below the surface the deposits ended. The ore averaged 57 per cent iron, with very small amounts of sulphur and phosphorous. The deposit was stratified and was probably formed in very ancient times by water circulating through an enormous mass of silica and iron oxide. The silica was leached away, leaving the less soluble iron minerals concentrated as ores. The process of leaching must have gone on for very long periods of time because silica is not particularly soluble though it is more so than iron oxide.

More than 100,000,000 tons of iron ore still remain in the Michipicoten area.[30] Another reserve, equally large, is located at Moose Mountain, 25 miles north of Sudbury. Unfortunately

[29] Kaeding, C. D., "The Helen Mine and Beneficiating Plant", *Trans. C.I.M.M.*, 1940, pp. 207-16.

[30] Ontario Research Foundation Bulletin, 1934, *passim*.

in both districts the iron content of the ore is only about 35 per cent, which is too low for commercial use. The ores can be improved by treatment or beneficiation. At Michipicoten the ore can be crushed to one-quarter inch sizes, mixed with coke and water and then heated in rotary kilns to temperatures of about 550 degrees Centigrade. At Moose Mountain the ore can be ground fine and the iron removed by magnets. The ferrous content can be increased to over 50 per cent, sulphur almost eliminated and the weight of the original ore reduced by one third. The quality of the resulting ores is equal or superior to the average grade marketed in the United States but the processes are expensive. Despite many efforts by government and private researchers no method has been yet devised for putting beneficiated ores on the market at a price low enough to compete with American ores already concentrated by nature. The government of Ontario pays a subsidy on iron ores mined within the province and the Michipicoten ores are now being used again.

At Atikokan, 135 miles west of Port Arthur, ore of 60 per cent iron content was mined from 1909 to 1911. Operations were abandoned due to the high proportion of sulphur which makes iron brittle. In 1939 a large reserve of high-grade ore was discovered not far distant from Atikokan beneath the waters of Steeprock Lake. The lake has been drained and the ore is being mined to fulfil war needs but it remains to be seen whether the ore is sufficiently rich and the cost of mining low enough to allow the product to be sold under peacetime conditions in competition with cheap American ores. At various places chiefly in Quebec and in the Frontenac axis north of Kingston, Ontario, there were formerly scattered mines producing ore of fairly good quality from small lenses or "pods". There is no output from these at present. The profitable mining

of iron on a large scale within the Shield must await the discovery either of new high-grade resources,[31] or of new and cheaper processes for improving the very large reserves already known to exist. A more remote possibility is that the price of iron ore will rise as the rich United States reserves south of Lake Superior become exhausted.

The Shield has a number of minor mineral resources. Graphite, a soft crystalline form of carbon is obtained in many places but chiefly in a lenticular deposit 25 miles southwest of Renfrew. It is used in lead pencils, paints, polish, lubricants and crucibles. Difficulty is often experienced in treating the graphite so as to eliminate the accompanying minerals, especially mica, and thus obtain a pure product suitable for use in crucibles where most of the world's output is consumed.

Talc, a very greasy mineral, is mined at Madoc, 60 miles northwest of Kingston. It is used for cosmetics and also as a filler for paper, paint and rubber goods. Soapstone, which is talc in a dense and massive form, is found at various points in Quebec. Since it can be sawn into blocks, it is used for buildings. It is also used in slate pencils, electrical switchboards and, after pulverization, as a filler in asbestos composition and in various types of floor coverings.

The world's largest mica mine is located at Sydenham, 20 miles north of Kingston and there are other reserves just north of the Ottawa River. Although mica is a mineral constituent of many common rocks it can be extracted commercially only when rocks, usually intrusions of pegmatite, have cooled off so slowly that very large crystals are formed. One crystal from the Sydenham mine is said to have been more than nine feet in diameter. Mica is used as an insulator around boilers and pipes,

[31]A large reserve of ore with 38 per cent ferrous content is known to exist on the Belcher Islands. Flaherty, R. J., "The Belcher Islands of Hudson Bay", *Geographical Review*, vol. 5, June, 1918, pp. 433-58.

in patent roofing and in the electrical industry where high resistances are required.

Many important deposits of feldspar are found in the same general area as mica. Many of the deposits are too small to be worked but a few have areas of an acre or more at the surface and extend to great depths. Feldspar is used in emery wheels, abrasives, soaps, vitrified sanitary ware, and tiled floors. High-grade feldspar is used in making artificial teeth.

An important reserve of magnesite is found just north of the Ottawa River fifty miles west of Montreal. It is used in fire-resisting paint, in making paper and flooring, in cement, for stucco and particularly as a refractory material for lining furnaces and steel converters.

Lead and zinc, chiefly the former, are mined 33 miles west of Ottawa city, 45 miles west of Quebec City, and just north of Kingston. Lead and zinc are usually found together for they are both derived from hot solutions intruding into other rocks under similar geographic conditions. Typically, as in southern British Columbia, the deposits extend as deep into the earth as it is economically possible to carry on mining but in the southern parts of the Shield the deposits have been eroded so extensively that the present reserves are shallow and small. On the other hand, the more northerly zinc-copper deposits, those associated with gold at Rouyn and Flinflon, appear to extend to great depths beneath the present surface of the land. Lead is used in type, in bearings, paint and in pipe. Zinc is used to galvanize sheets of iron and in the manufacture of brass.

Radium is a very valuable mineral discovered in 1930 at the east end of Great Bear Lake, 28 miles south of the Arctic Circle.[32] The concentrated ore is sent by steamer 1,450 miles to Waterways, Alberta, and thence by rail to Port Hope, on Lake Ontario

[32]Walli, E. J., "The Eldorado Operations at Great Bear Lake", *Trans. C.I.M.M.*, 1938, pp. 61-3.

east of Toronto, where it is refined. Radium is used in medicine and to a small extent in luminous paint. Formerly produced only in the Belgian Congo, its price was about $60 a milligram. Canadian output has added to the world's supply of this vital element and has cut its price by over 60 per cent. The ore, pitchblende, from which radium is secured, is greyish-black, opaque, and so lacking in distinctive characteristics that large resources which exist elsewhere in the Shield may easily have been overlooked. The same ore which provides pitchblende also yields silver, copper, cobalt, lead and uranium. The latter is used as an alloy in steel and as the yellow colour in pottery and glass.

The very great importance of all these minerals to the Shield and indeed to all Canada raises the problem of the future of mining.[38] All mineral deposits are exhaustible. No matter how efficiently operations are conducted or how large the reserves originally are, the mine eventually depletes its resource and must close up. Moreover the life of a mine is uncertain. A study of climate, soils, transportation facilities and so on enables one to determine where wheat can be grown, but despite the remarkable advances in geology in the last few decades, no one can tell accurately where ores can be found or how large their mass actually is. Science has taken a lot of the guesswork out of mining but the industry is still basically unpredictable. Even when a large ore body has been profitably used for many years, it may be made worthless by the discovery elsewhere of higher quality or more favourably-located ores, or the development of new techniques in treating ores. For example, the perfection of the flotation process in Canada destroyed to some extent the

[38]Bruce, *op. cit.*, pp. 413-6; Crerar, T. A., *The Future of Canadian Mining* (Ottawa: Dept. of Mines, 1936); O'Neill, J. J., "The Exploitation and Conservation of Mineral Resources", *Trans. Royal Society of Canada*, 1940, sec. 3, pp. 1-14; Williams, M. Y., "Progress—Planned or Improvised", *ibid.*, 1941, sec. 4, pp. 151-65.

value of the lead mines in Spain. Another feature of the mining industry is that the demand for metals, besides fluctuating with the business cycle, may experience long-run trends. The demand for nickel has been steadily going up and that of silver declining. Minerals can be stored for long periods without deterioration and low prices due to over-production are likely to persist for some time until stocks are worked off the market. Finally, mineral production is localized to a greater extent than other industries. All the world's radium comes from two small areas, one in Canada and the other in the Belgian Congo. Within a heavily mineralized area like the Shield, the mines are scattered and the density of population low. Exhaustibility, unpredictability, storability and localization of mines are significant factors in the mining everywhere, including the Shield.

The economic problem of the future of mining in the Shield can be postulated in a single question—how long will mining last? There seems to be little doubt that the demand for metals will be maintained and will probably increase. The demand for iron may possibly diminish but that for alloys and lightweight steels will rise. Such a shift would be to the advantage of Canada, whose position in iron and steel is weak while in alloys and aluminum it is strong.

Assuming that demand will continue, the problem for Canada is one of meeting the competition of other areas. No one can prophesy what competitive forces may develop but it can certainly be affirmed that Canada has a very much larger area of Precambrian rocks exposed at the surface than any other country in the world except, perhaps, Russia. Her other rivals, Finland and the Belgian Congo, are far behind. The Precambrian formations seem to possess in a greater volume and variety than other types of rocks, the minerals which have an increasing world demand. Yet competent geologists are doubtful whether the huge more or less unexplored sections of the

Shield, which apparently consist of either Athabaska sandstone or Keweenawan-like rocks, are as heavily mineralized as the granites and gneiss which have already been prospected. "Probably the most favourable area for workable deposits is the area which has received the most attention".[34]

Even if one accepts the view that the southern border of the Shield is the most valuable part of it, it is unlikely that all the large mineral deposits near the borders have been located to date. Parts of the Shield are covered with glacial drift and clay. Undoubtedly minerals lie beneath this cover and have been overlooked by prospectors. The old method of prospecting was, essentially, to examine visually the surface of the earth in districts where the rock formations seemed to indicate mineralization. Recently the methods of prospecting have been improved and put on a scientific basis by the development of geophysics. This new science is based on the idea that underlying deposits of mineral ore differ in their physical properties from the overburden and from the surrounding rocks. Consequently, ore and barren rock will not react in the same manner to various forms of energy such as electricity, sound and radio waves. Geophysical prospecting involves transmitting energy through the earth and then using very sensitive instruments to measure the slight differences between the effect when, say, a radio wave strikes an ore body and the result when it comes in contact with other types of rock below the earth's surface. Delicate instruments are also used to detect rocks which are radio-active, as many rocks are to limited extents. The chief limitations on geophysical prospecting are that it is difficult to locate small ore bodies and it requires a great deal of energy to penetrate deeply within the earth. Although geophysics is less satisfactory in complex rock structures like those of the Shield than it is in the simple, flat-lying rocks in which oil is commonly located the science is being increasingly

[34]Bruce, *op. cit.*, p. 416.

applied in the Shield. It represents a definite advance in the possibility of discovering new resources to replace those being depleted.

Some of the earlier notions of the Shield's mineral wealth have been found to be incorrect. It was formerly thought that many of the ores were in relatively shallow formations. This is undoubtedly true for hundreds of properties but in some areas, notably at Kirkland Lake, ore bodies extend to very great depths without diminution in volume or reduction in quality. Good mines die hard. In 1924 Dome Mines were estimated to have a life of 2 or 3 years. New discoveries of ore at greater depth enabled production to be maintained until in 1929, the future life was estimated at four years. The mine is still producing, however. In short, northern parts of the Shield may not be as heavily mineralized as the borders which are now being exploited but new methods of prospecting may lead to new discoveries and the presence of ore bodies at considerable depths below the surface may allow a relatively long life to at least some of the mines.

Assuming the minerals to be present, will Canada be able to produce minerals at costs low enough to compete with other countries? To answer this question one needs to know something of the problems and methods of developing a new mine in the Shield. After outcrops of ore have been observed on a certain property some of the glacial drift has to be removed in order to determine the dimensions of the ore body at the surface. Then a small hole is driven into the rock with a rapidly rotating circular drill, the cutting edge of which is studded with diamonds. The core of the drill hole is raised to the surface of the earth, assayed to determine the richness of the veins and examined to show their depth beneath the surface. If the metallic content appears to be high enough to cover the cost involved, mining may be

tentatively started. How rich the ore has to be to justify development cannot be stated categorically. Much depends on the nature of the ore body, the ease of milling, the cost of transportation and so on. In Ontario in 1937 one mine had ore with a gold content of $25.26 a ton, another had ore with an average gold value of $2.36 per ton. Both paid dividends. Assuming the ore to be rich enough a shaft is sunk and, possibly, a stamp mill erected to prove up the mine.

Meanwhile, a group of men who make a practice of purchasing likely-looking properties from prospectors have been trying to raise enough money to bring the mine into the producing stage, to the point where metal is mined, milled and sold to cover at least part of the costs of mining. Some mines may be brought into production with the expenditure of a few hundred thousand dollars to meet the cost of prospecting, diamond drilling, building a stamp mill, organizing transportation facilities, sinking shafts and drifts, purchasing mining equipment, erecting a power plant and mill and so on. Large and isolated deposits may cost two or three million dollars to develop. Flinflon[85] cost $27,000,000 up to the time when the first returns were received from the sale of metals. This property was discovered in 1914. In the next two years $50,000 was spent in diamond drilling before exploratory work was abandoned. The ore was too complex to be handled by the processes in use before flotation was perfected. In 1917 and again in 1920 further efforts at development were made. In 1925 a test plant was constructed. Two years later a branch railway line, 80 miles long, was built into the district superseding the tractors and sleds previously used. A hydro-electric power plant was built at Island Falls 75 miles north of Flinflon. The whole project required money, skill, and courage on the part of its promoters. Lack of these qualities may lead

[85]Phelan, R. E., "History of Flin Flon up to Construction", *Trans. C.I.M.M.*, 1935, pp. 55-70.

to delay in opening up the mineral wealth of the Shield but will not indefinitely prevent mining development provided the ores are there to begin with.

Besides raising capital, the new mine will have the problem of transportation. The prospectors who make the preliminary explorations can go through the Shield on foot, by canoe, or, occasionally, by dog-team. If necessary, they can "live off the country" by hunting and fishing. Obviously this is not possible for the large numbers of men who are needed for developing a new property or operating an established mine. All machinery for the mine, large amounts of mine supplies, food and other necessities for the men have to be brought in from the outside. Finally, the minerals produced on the property must be sent out. In the case of gold and radium mines the final output is not bulky but base-metal mines are not in the same fortunate position with respect to their ultimate product. Good transportation facilities are fundamental to sound mining development.

Now it so happens that parts of the Shield are supplied with railways which were constructed for other purposes than giving access to mines but are now available for their use. Railway lines were built to give transcontinental service, to open up the Clay Belt, or as part of the Hudson Bay route. Often through lack of knowledge of where ores existed, the lines do not touch the mines themselves. Branches such as those at Flinflon, Timmins, Noranda, and Rouyn-Senneterre have had to be constructed. Thus a few mines have had railway service almost from their very beginning but on the whole, railways have not been used as extensively as one might expect.

An early problem in railway construction arose from the existence of muskegs or swamps of sphagnum moss.[36] Every summer when the surface of the muskeg thawed out, the track

[36]Innis, H. A., "The Hudson Bay Railway", *Geographical Review*, vol. 20, January, 1930, pp. 1-30.

settled down into the morass and, if it did not disappear entirely, it got out of alignment so that the trains could not operate on it. This difficulty was overcome by building the railway during the winter and covering the surface of the muskeg with a thick and relatively broad layer of ballast. The ballast prevented the summer's heat from penetrating to the swamp beneath the track and so the trains run on a permanently frozen sub-strata.

Nevertheless, the cost of railway construction still remained a limitation. Unless the volume of traffic handled to and from the mine is very large, the revenue will not be enough to cover the interest charges on the large capital investment. Because all mines are depleted sooner or later, it is not profitable to build railway lines to small isolated properties. This is particularly true because, once the mine is exhausted, only a small percentage of the original value of the railway, other than rolling stock, can be salvaged for use elsewhere. The construction of railways into mining camps can be economically justified only if the camp is large and is likely to be fairly permanent such as Flinflon or Noranda. For the numerous smaller properties some other means of transportation is essential.

At present some of the smaller, more isolated mines try to get in all the supplies they can during the summer when barges can operate along the numerous interconnected lakes and rivers of the Shield.[37] The barges, which have draughts of from 3 to 4 feet and 150 or 200 tons capacity, are pulled by tugs with diesel or gasoline engines. Where barriers of rock separate lakes from each other or where there are rapids, the freight has to be unloaded from the barge and portaged by wagon, truck or ordinary steam railway. Sometimes marine railways are built where the barriers are only a mile or two in width. Rails are

[37]Bryne, J. G., "Development Costs at Goldfields, Saskatchewan", *Canadian Mining Journal*, vol. 60, January, 1939, pp. 23-5; D'Aeth, J. B., "Freight Hauling in the Undeveloped Territory of Canada", *Engineering Journal*, vol. 20, September, 1937, pp. 706-17.

laid down across the portage and then extended for short distances beneath the water out from the shore of the lakes at either end of the rock barrier. A barge is floated above the railway track and is hauled toward the shore by a cable. Soon the barge comes to rest on the top of bogie trucks, similar to those under railway cars, which run along the track under the water. As the barge is hauled closer toward the land the trucks are pulled in with it and gradually they lift the barge out of the water. The barge is carried on the trucks across the portage and out on the submarine tracks at the other end of the line. Here the barge floats off the trucks and is hauled by tug either directly to its destination or to another marine railway. The experience of McKenzie Red Lake Gold Mines,[88] 95 miles north of Kenora, Ontario, is a good example of this type of transportation. All heavy supplies are hauled in during the summer by barge along a succession of lakes and rivers from the railroad at Hudson, 180 miles to the southeast. There are four marine railways along the route and the average cost of transportation is a little more than 11 cents for hauling one ton one mile.

Mines along the Mackenzie and its tributaries are able to use water transportation for four or five months during the summer.[89] On account of the shallowness of the river, the shifting character of the channel, and the frequent presence of sand-bars, paddle-wheel steamers like those on the Mississippi where similar navigation conditions prevail, are used. Some of the vessels were built at Sorel, Quebec, dismantled, shipped by freight car to the railhead at Waterways, Alberta, and re-assembled there. Other ships were built at McMurray and Smith of local and imported raw materials. Due to the shortness of the navigation season and the great expense of bringing in bulky goods by plane during the

[88]The Staff, "McKenzie Red Lake Gold Mines", *Trans. C.I.M.M.*, 1938, pp. 343-57.

[89]Lloyd, T., "The Mackenzie Waterway; a Northern Supply Route", *Geographical Review*, vol. 33, July, 1943, pp. 415-34.

winter, the purchase of supplies and equipment must be carefully planned. Mines in remote locations like the radium property on Great Bear Lake must be as self-sufficient as possible during the winter. They maintain their own repair shops and use whatever local supplies of fish and native animals they can.

While some mines get in their supplies during the summer a few chiefly rely on winter transport by tractor train[40] and others use tractors for supplementary service. A tractor train consists of four to six sleds hauled over snow or ice by a caterpillar tractor with diesel engine. The trains haul from 60 to 100 tons of freight at average speeds of about three miles per hour when loaded and seven miles light, depending on the steepness of the grades and the condition of the snow. Since tractors are costly pieces of equipment, they are operated as continuously as possible, with relays of drivers who eat and sleep in a "caboose" at the end of the train when off duty. Tractor trains move over the ice of lakes and rivers or along roughly-built roads. The "right of way" must be used fairly regularly in order to keep the snow packed down for good sledding. The costs of operating tractor trains vary from 15 to 25 cents per ton-mile.

It is the aeroplane, however, which constitutes the chief improvement in the transportation facilities of the Shield.[41] Planes are used to fly prospectors and their supplies into new areas in the spring and out in the fall. This is important because it allows them to take full advantage of the short summer season when the snow is off the ground and prospecting is possible. Flying is less expensive and laborious than travelling by canoe. Once a favourable mining prospect has been located, diamond-drilling equipment, a diesel engine or steam boiler and even a stamp mill may be flown in to prove up the mine. If the mine

[40]D'Aeth, *op. cit.*

[41]Currie, A. W., "Some Economic Aspects of Air Transport", *C.J.E.P.S.*, vol. 7, February, 1941, pp. 13-24; Bruce, E. L., "The Canadian Shield and its Geographic Effects", *Geographical Journal*, vol. 43, March, 1939, pp. 230-39.

is likely to be a large and more or less permanent one, aerial photography will assist in locating the best route by rail or water to the camp. Even after other transportation facilities have been provided to the camp, planes may be used to give speedy delivery to passengers, mail and spare parts for machinery. At some camps such as Goldfields[42] on Lake Athabaska, Saskatchewan, fresh fruits and vegetables were formerly flown in Now a refrigerator barge brings in perishable goods during the summer. Some of the goods are left in cold storage—an easy matter—for winter use, while steers and hogs brought in by one of the last barges in the fall are slaughtered when the cold weather sets in. Still for many isolated camps, planes are instrumental in adding variety to the diet. In all cases they maintain speedy communication between mines and the outside world both in summer and winter, except for a few weeks in the spring when the ice moves out of the rivers and lakes and again in the autumn when the ice is forming.

The chief drawbacks of planes are their high cost of operation and the fact that they may "skim" the resources of the Shield. Planes land on lakes during the summer and on ice in winter. There is no expense for landing fields and, of course, none for right-of-way. Even so, planes are expensive to operate due to their heavy initial cost, the price of high-octane gasoline which they require and the small load of revenue-freight or passengers which they carry. Rates quoted by aviation companies operating in the Shield range from \$1 to \$1.50 per ton-mile for freight and 25 cents a mile for passengers.

Because of this cost, it is profitable to exploit by plane only the richest deposits of ore. Usually along with the high-grade ore there are large quantities of ore with lower metallic content. It would pay to develop the latter if some of the superior ore

[42] Jewitt, E. G. and Gray, S., "The Box Mine of the Consolidated Mining and Smelting Company", *Trans. C.I.M.M.*, 1940, pp. 447-57.

could be mixed with it but it is not profitable to use it alone after the better deposits have been removed. The use of the aeroplane may mean that some of the fairly good ore reserves will be left behind more or less indefinitely. The wealth of the country is thereby reduced.

Barges, tractor trains and planes have made possible very definite advances in developing the Shield, even though their use is not without its dangers. By cheapening the cost of operating these agencies, it will be possible further to explore and exploit the mineral resources. Efficient, economical transport is essential in order to maintain and extend the prosperity of the Shield.

Mining has the problem of securing adequate supplies of fuel. The crystalline rocks of the Shield itself are barren of coal and petroleum and the majority of its mining camps are not favourably located with reference to outside sources of these fuels. An exception must be made for the radium mines[43] at Great Bear Lake which are able to secure ample supplies of cheap oil from Norman. Unfortunately, other camps must, at great expense, bring in gasoline and fuel oil for use in tugs, caterpillar tractors and stationary power plants. In the southern parts of the Shield there is plenty of wood for raising steam in boilers but the shortage of cheap labour prevents its being used on a large scale. Farther north the wood is small in size, poor in quality, and quite unsuited for steam raising.

Most mines begin to develop and use hydro-electric power once they reach the producing stage. For reasons to be indicated below, hydro-electricity can be produced cheaply in the Shield. This is true even though the capital cost is high, the life of a mine is short and the annual interest and depreciation charges heavy. For example, to supply the camp at Goldfields,[44] a large

[43]Camsell, C., "Great Bear Lake: An Exploration and Its Sequel", *Canadian Geographical Journal*, vol. 14, March, 1937, pp. 127-51.

[44]Stiles, R. M., Wellington Lake Power Project", *Trans. C.I.M.M.*, 1940, pp. 468-80.

project was constructed consisting of a dam 75 feet high, the requisite flumes and generators, a transmission line 22 miles long and a diversion canal to connect two lakes, thus increasing the volume of water and the amount of power which could be generated near the dam. Supplies had to be brought in by barge 220 miles from railhead at Waterways, Alberta, to Goldfields and thence 25 miles by air to the site of the dam. Planes flew in fuel oil, gasoline, a steam shovel, steel rails, dump-cars for ore, a gasoline locomotive and three 2-ton trucks, as well as food and the men themselves. The total cost was $1,500,000 and the estimated life of the mine only ten years. Despite the high annual interest and depreciation charges, it was cheaper to develop electricity than to use diesel engines with imported fuel.

Plainly, access to ample relatively cheap hydro-electric power is very important to mining development in the Shield. Electricity is used for lighting, for lifting elevators in the shaft, for operating rod or ball mills and agitators, for compressing air to operate the steel drills, and for charging the storage batteries which provide power for the locomotives pulling cars of ore along the drifts and cross-cuts. Electricity is also used for pumping water and operating the ventilating system, though these are not nearly as important as they are in coal mines due to the small amount of seepage in crystalline rocks and the absence of firedamp.

Mining in the Shield sometimes has the advantage of nearby supplies of wood for buildings, for supports and lagging within the mine and for fuel. Sand and gravel from glacial drift are usually available for constructing dams and the foundations of buildings and for back-fill in the stopes. The market for all the metals which are produced in the Shield appears to be growing. Some of the mining companies, notably International Nickel, have been very aggressive in finding new uses for their products. Besides spectacular technological developments like flotation, there have been small but steady improvements in the methods

of mining and milling ores. The cumulative effect of numerous small advances has been very great. Greater attention is paid to securing purity of product and to the exploitation of by-products. Increasing knowledge of geology has eliminated much of the guesswork from the development of both old and new properties. The financial success of some of the ventures has helped in the raising of money to develop new properties.

The net results of all these changes are lowered costs, increased output due to more complete extraction of minerals from ore, and the bringing into production of lower-grade ore bodies which it did not pay to use under the old methods. Yet when all is said and done, mining remains an extractive industry. It takes away resources from the crust of the earth and never replaces them. It is intrinsically unstable and unpredictable. It is so highly localized that population is always relatively scattered or else concentrated in a few isolated pockets. When the reserves in any one area are depleted, the people may be cast completely adrift. Hard-rock mining is not a satisfactory basis on which to build an economy. Although there is no immediate danger that the prosperity of mining in the Shield will disappear, there is no definite assurance that it will be permanent.

Hydro-Electric Power

To outline the geographic and economic factors behind the development of hydro-electric power in the Shield[45] is to recapitulate with somewhat different emphasis what has been said in this connection for other Regions. The rivers tumble over rocky ledges from one level to another and the rainfall is good so that there

[45]Blanchard, R., "Geographic Conditions of Water-Power Development", *Geographical Review*, vol. 14, 1934, pp. 88-100; Brouillette, B., *Le Développement Industrial de la Vallée du Saint-Maurice, Trois-Rivières*, 1932; "Combustibles et Force Motrice", in Minville, *op. cit.*, pp. 240-70; Johnston, J. H., "The Water-Power Resources of Canada and their Utilization", *Canada Year Book, 1940*, pp. 353-64; Senecal, G., "La Tuque et le Haut St.-Maurice", *Études Économiques*, vol. 3, 1933, pp. 7-36.

is the necessary combination of the two fundamental factors, water and height. The drainage systems of this heavily-glaciated peneplane are so badly deranged that it is comparatively easy to blast new outlets for streams and lakes and thus increase the flow of water past the power site. The relative lack of soil over the surface of the Region reduces the amount of silt carried down by rivers and what little is eroded soon settles in the innumerable lakes. Silt is objectionable in the generators and, if deposited in large amounts in the quiet waters above the dam, cuts down the storage capacity of the reservoir. Though the scarcity of soil is detrimental to the Region as a whole, it is of some advantage in the generation of hydro-electricity.

Precipitation is relatively regular throughout the year and from one year to another. Evaporation is low due to the cool climate and the cover of forest. In the southern Shield particularly, the trees and underbrush slow down the rate at which snow melts in the spring. They tend to retain rainfall about their roots and allow it to run off slowly throughout the year. The large numbers of lakes act as storage basins for the water. As a result of all these natural forces the difference between the maximum and minimum flow is not nearly as great as in the Cordillera but somewhat more than at Niagara.

Dams are usually necessary to pond some water and raise the amount of "firm" power but the quantity of water that needs to be stored by artificial means is never great relative to the total flow. Land can be flooded without incurring any expense for moving settlers and compensating for loss in property values. The trees growing on areas to be inundated can be removed before flooding takes place. The foundations of the dams are solid. Lumber and gravel for constructing dams and buildings are readily available though cement is expensive. Some of the sites are isolated. This increases the original cost of construction and the amount of interest that must be paid over the life of the

project but few people are needed to maintain and operate the works once they have been built and so there is no continuous expense for hauling in large quantities of supplies. For this reason tractor trains were used to bring in equipment to the power plant at Island Falls while a railway was constructed to Flinflon.

The power can be sent by high voltage transmission lines to the consumers who are mainly pulp- and paper-mills and mines. When coal is the source of power or heat, it is necessary to locate the factory at the coal mine or haul the bulky coal to the factory. To transport coal is expensive whereas up to distances of from 250 to 300 miles it is fairly economical to transmit electricity despite the heavy capital cost of the line and some loss of energy in transmission. A factory using electricity can be located to take advantage of easy access to market or to some raw material other than power. This is often a gain of some importance.

A possible handicap to the generation of hydro-electricity in the Shield is the presence of ice at certain seasons of the year. Fortunately ice can be fairly easily controlled by any one of a number of different methods. Large rivers never freeze to the bottom and plenty of water is always available in the lakes for power. The intakes and flumes can be built narrow and deep, thus increasing the velocity of water flowing through them and preventing ice from forming. Cakes of floating ice can be kept back from vulnerable points by simple barricades, by drawing the water from the bottom of the river, or by constructing the intake at right angles to the surface current which, if it is rapid, will carry the ice past the intake. At some power sites frazil, or needle, ice gives trouble. This difficulty is overcome by running the plant as lightly as possible for a night or two at the beginning of the first cold snap in the fall. A sheet of ice is allowed to form above the intake channel and thereafter frazil ice is not a problem. The method of controlling ice which is

adopted by any particular plant will vary with weather conditions at the time and with the detailed topography about the site.

By far the most important limitation on hydro-electric development is the high capital cost involved. The drainage basin above the site must be very carefully surveyed. The amount of the rainfall, runoff, seasonal and annual changes in the flow and so on must be carefully measured. Dams, generating and transmission systems must be constructed. Expert engineers must be employed and interest has to be paid while the facilities are being built even though the company is not yet in a position to earn any income from the sale of power. Even when the dam is completed, the company may have to wait a long time until a market is found for all the power which it is capable of producing. All these factors mean heavy payments for interest which have to be met in good times as well as in bad. Water-power developments proceed most rapidly when interest rates are low and when business stability seems to be assured. Power projects in Ontario have the added advantage that they can borrow money with the guarantee of the provincial government.

Although the high capital investment is a limiting factor on the development of hydro-electricity, the advantages of the Region more than offset this cost and it is cheap to generate large amounts of electrical energy in the Shield. The Ontario Hydro-Electric Power Commission quotes a rate of $17.50 per horsepower per annum in the Abitibi district.[46] This rate is available only to purchasers who undertake to buy a large stipulated amount regularly over long periods of time. If the consumer does not use the agreed-upon amount consistently, he is penalized and usually only mines and newsprint mills qualify for the rate. It is difficult to compare the relative costs of electricity and coal,

[46]Hogg, T. H., "Power Development in Northern Ontario", *Engineering Journal*, vol. 20, March, 1937, pp. 124-30; Douglass, D. P., *Hydro-Electric Development for the Mining Industry of Northern Ontario* (Toronto: Ont. Dept. Mines, 1944).

though it has been authoritatively stated that each installed horse-power of hydro-electricity saves about five tons of coal per annum.

As already pointed out in connection with the Cordillera, electricity competes with other sources of energy like coal and petroleum. Neither of these fuels is available in the Shield itself nor are they present along its edges except in insignificant amounts or in poor quality. The nearest large source of high-grade fuel is in Pennsylvania, several hundred miles away. For all practical purposes the Shield is without coal and oil and hence hydro-electricity has a virtual monopoly of the demand for industrial power.

Cheap electricity is one of many factors leading to the development in the Shield of newsprint manufacturing and mining, and is primarily responsible for attracting certain chemical and metallurgical industries. To produce a ton of newsprint requires from 60 to 80 horse-power daily. Between 40 and 45 per cent of all the hydro-electrical power generated in the two provinces of Ontario and Quebec (Shield and Lowland) in 1938 was consumed by the newsprint industry. In mining and milling one ton of auriferous ore from 2½ to 5 horse-power is needed. Steady reductions in the cost of electricity have permitted the use of increasingly lower-grade ores. Thus the life of the older mines has been extended. Cheap power has made it possible for new mines with ores of low mineral content to be opened up. Due to lower expenses mines with higher-grade ore make larger profits and more money is available for investment in other mines or elsewhere in Canada. The benefits of the hydro-electric development in the Shield show up in the prosperity of the mining industry.

Cheap water-power has also led to the establishment of electro-chemical and electro-metallurgical industries at the edges of the Shield. At Shawinigan Falls abrasives such as carborundum and

high-grade ferro-silicon are manufactured. Carbide is made by treating lime and coke in an electric furnace at a temperature of 3,000 degrees Centigrade. In compounds with other chemicals, carbide is used for lighting the lamps which miners wear in their caps, for oxygen-acetylene welding and for the manufacture of dry batteries, printing inks, cellulose products and duco paints. It is also in demand for shortening the time of manufacture of automobile tires and giving them increased strength.

Another industry attracted to the Shield by cheap power is aluminum manufacturing.[47] One of the chief raw materials is bauxite of which Canada produces not a single ton. As a matter of fact, aluminum is the third most abundant element in common rocks. Every clay bank consists of from 20 to 25 per cent aluminum but it is usually so closely locked up in chemical combinations that it cannot be extracted on a commercial scale. Only when rocks have 50 per cent or higher of alumina content and are low in silica and iron oxides, is it profitable to use them to manufacture aluminum under prevailing methods of extraction. Such ores are obtained chiefly in British Guiana and are brought in by water to the excellent and rapidly growing port of Chicoutimi. At the nearby city of Arvida, these ores are smelted in an electric furnace, treated with small amounts of cryolite which is an aluminous rock imported from Greenland, and then reduced by passing a strong electric current through the "bath" of chemicals. The electricity causes pure aluminum to sink to the bottom of the vat. In order to produce one pound of aluminum, about six pounds of bauxite and enough electricity to keep a 40-watt bulb burning for more than 12 days is required.

Aluminum is a white metallic element which weighs only one-third as much as nickel, copper, zinc or steel. It is more expensive than the metals named but, because of its superior qualities,

[47]Kennedy, E. V. N., "Canada's Aluminum Industry", *Canadian Geographical Journal*, vol. 27, November, 1938, pp. 248-70.

smaller amounts need to be used to withstand the same pressure or weight. In its pure state, aluminum is soft and malleable but can be made very hard and strong by properly alloying with small amounts of copper, silicon, manganese, magnesium or nickel. The lightness of aluminum means that less tare, or dead weight, needs to be lifted in a plane or hauled in the railway locomotive and cars. Less gasoline and coal will be needed than at present to transport a given number of passengers or volume of freight. In the case of trains, light-weight steel will mean that the rails, tie fastenings and bridges need not be as heavy and expensive as they now are. All these savings will benefit the public through lower freight rates and the conservation of natural resources. Pure aluminum is an excellent conductor of electricity and is often used for this purpose in Europe where copper is scarce. In North America high-power transmission lines like that from the power plants on the Gatineau River near Ottawa to Toronto, are made from aluminum reinforced by a steel wire or cable. Since it is not attacked by certain acids, aluminum is used for electrodes in chemical processes such as the manufacture of rayon. Finally, it can be made to take a high polish and is used for reflectors.

In view of these attributes it is expected that the consumption of aluminum will increase rapidly within the next few years. In this event the Shield will have great advantages in its production because of its large supplies of cheap power needed to economically extract the element from the bauxite. This power can be transmitted without too great cost to the ports when the bauxite can be brought in cheaply by ocean steamship. The increasing use of aluminum and its alloys will strengthen Canada's industrial position by partially overcoming her relative deficiency in coal and iron.

All in all, hydro-electric power is a very important resource in the Shield. It has stimulated the development of some older

industries and attracted new ones. With the exception of agriculture, it is the only resource in the Shield which is not exhaustible. This is exceedingly significant because this Region, rich though it now is, lacks permanent sources of income.

The Fur Trade

Canada's first commercial contacts with the rest of the world arose through the fur trade. Under the French Regime furs were "both the mainspring of development and discovery, and the curse of settled industry". Until the early years of the nineteenth century, the export of furs from Canada exceeded in value those of any other single product. The total output has not seriously declined over the past century and a half though now the fur trade is greatly overshadowed by other economic activities.

The general methods of carrying on the trade have not changed radically in the last few decades.[48] As a general rule trappers work singly and operate trap-lines from 20 to 60 miles long. At intervals of from 10 to 15 miles along the line, the trapper erects a small log cabin. Nearby in a cache on poles beyond the reach of predatory animals he stores some food. Each cabin provides the trapper with overnight lodging and food while he is tending the line. After the first snowfall the trapper inspects the district carefully to find out where the tracks of animals are most abundant. Knowing the habits of the fur-bearing animals he places from 100 to 150 steel traps in suitable places along the line. He visits the traps weekly or oftener, removing the animals which have been caught and resetting the traps. After skinning the animals, the trapper carefully scrapes all the flesh from the inside of the pelt, flexes it to make it supple, stretches it and generally keeps it clean and pliable until the following spring.

[48]Innis, H. A., *The Fur Trade of Canada* (Toronto: Oxford University Press, 1927).

Then he goes "outside", sells his furs, and purchases supplies for another winter's work.

Furs are produced in every province of Canada but the steady advance of agriculture, forestry and mining has tended to push the production of wild furs back into the more remote sections of the Shield and into the Tundra. This is particularly true of fisher, marten and lynx which seem to be on the way to extinction; but a few species, notably foxes, mink, rabbit, skunk, and weasel, are able to maintain themselves despite the onslaught of civilization.

In producing furs the Shield has several distinct advantages. The best-quality furs are raised in relatively cold climates. The forests provide cover for large numbers of mice, rabbits, birds and other creatures on which the carnivorous fur-bearers live. The bark of trees supplies food for beaver and the roots of aquatic plants are the chief articles in the diet of muskrats. The maze of rivers and lakes enables trappers to penetrate deeply into the Region by canoe. Snow on the ground for long periods of time helps trappers to locate the fur-bearers. The absence of other economic activities over wide areas preserves the primeval conditions preferred by wild animals.

Whether or not the number of fur-bearing animals is decreasing is a question to which there is no definite answer. It is reasonable to expect that continuous trapping will reduce the animal population. In recent years traps have been improved and also made lighter in weight so that the trapper can carry more of them into the older trapping districts and penetrate distant areas more easily. The number of full-time and part-time trappers shows no signs of diminishing and even increases when the price of furs is high or when there is unemployment elsewhere. The steady advance of settlement and the removal of pulpwood cuts down the area in which wild fur-bearing animals thrive.

Yet there is no clear evidence of a decline in animal population because of human exploitation. Instead there are cyclical fluctuations due to natural causes.[49] These cycles were first observed by employees of the Hudson's Bay Company more than 100 years ago. For a long time the Company kept the information secret and profited by its knowledge, because it held furs off the market when pelts of that species were plentiful and sold them a few years later when it knew that the supply would be small. Scientific study has shown that the number of the larger rodents fluctuates on a cycle of 9.6 years and that of the smaller ones on one of 4.2 years. The fluctuations may be due to an intestinal disease of changing virulence but obviously have no relation to the intensity of trapping. Variations in the population of rodents affects the amount of food available for the fur-bearers. Thus the numbers of the wild animals in which mankind has a direct economic interest varies greatly from one year to another. It seems inevitable that continuous trapping will reduce the output of pelts in the long run but accurate data are impossible to secure and the trends, if any, are so confused by the cyclical changes in numbers that no one can tell with certainty whether the wild fur-bearing animals are greater or less numerous than they were a few decades ago.

In any case, the demand for furs is increasing. This is due to the presence of a larger, more prosperous human population. In particular it is caused by an increase in conspicuous consumption, the desire to acquire distinction for oneself and one's family by possessing expensive, luxury articles like fur coats and neckpieces. Irrespective of whether there is a smaller total number of wild fur-bearers than there was a quarter-century ago, there are not enough to satisfy the demands of the consumers.

[49]Elton, C., "Fluctuations in Muskrat and Lynx Population in Canada", *Journal of Animal Ecology,* vol. 11, 1942, pp. 96-126; MacTaggart-Cowan, I., "Fur Trade and the Fur Cycle, 1825-57", *B.C. Historical Quarterly,* vol. 2, January, 1938, pp. 19-30.

In order to meet this situation, the supply is being increased by fur farming, by up-grading furs, and by conserving the wild life which still remains. Some of the problems of fur farming have been dealt with under the Acadian-Appalachian Region. Fur farms are now located in every province in Canada and supply about 40 per cent of the total value of all pelts sold in the Dominion. Silver fox and mink are the two most important animals raised in captivity but fisher, marten and chinchilla are being "farmed" on an experimental basis. Domesticating new species is a slow, expensive process. The problems of getting a suitable diet, of maintaining the health of the animals and of preventing their escape are hard to solve. Long careful observation, a good deal of "trial-and-error" and heavy costs must be incurred before the animals arrive at a state of even semi-domestication.

Up-grading involves the trimming, cleaning, matching and dyeing of plentiful, low-priced furs so that they resemble the more valuable species. At the same time the common furs are re-named; mink becomes sable, white rabbit ermine, skunk black marten, and muskrat is christened Hudson seal. "On the way to market many skins change into more aristocratic families than those of their plebeian childhood. The change of name is not publicly reported to the buyer and a higher price is charged for the title which is conferred on the journey."[50]

The conservation of wild fur-bearers raises a number of difficult problems. Once a decline in the population of a species begins (ignoring cyclical fluctuations) it is likely to be progressive, because as the furs become scarcer they also tend to become more valuable. The trapper is stimulated to further efforts and it becomes more and more difficult to reverse the trend. Similarly, if the government absolutely prohibits the killing of a certain

[50]Cadell, H. M., "The Resources of Canada", *Scottish Geographical Magazine*, vol. 32, March, 1916, p. 115.

species, puts on a closed season, or restricts the number of such animals to be caught by any one individual, it reduces the legal supply, makes the furs which come on the market more valuable, and "provokes a situation in which the temptation toward violation is more conspicuous and the necessity for rigid protection more urgent". If one province prohibits killing a species, its efforts may be nullified by poachers who trap the fur-bearers in the province, where their numbers are presumably increasing on account of the control and then easily smuggle the light, valuable furs into another jurisdiction for sale. Game wardens have an almost impossible task in applying the regulations due to the enormous territories involved. It is relatively easy to enforce laws prohibiting trade in certain types of furs or in furs caught in the middle of the closed season but such regulations defeat their own ends. Indians use for clothing furs which they cannot trade and so the species is not conserved.

One successful method of conservation which has been widely adopted is to license or register trappers. The licence fee is a fairly nominal amount because, if it were high, its effect would be to encourage the trapper to undertake more intensive trapping in order that he might pay the fee and still get his ordinary profit. Each registered trapper is given the exclusive right to trap in a certain small area and is assured that he will have the same territory in subsequent years provided he complies with the game laws. Thus he is given a long-run interest in conserving the wild life of the district. By relying on the profit motive of the trapper, the government hopes to keep down the steadily increasing cost of game law enforcement. In some jurisdictions Indians are not licensed and their poaching on the reserves of registered white trappers often leads to difficulties.

A variation of the same plan is the creation of fur-producing

preserves.[51] Companies and individuals lease crown lands for a nominal fee. The lessee keeps down the predatory enemies of the animals which he wants to catch and takes care to kill only the mature fur-bearers. Otherwise he leaves the animals alone in their native habitat without making any effort at domestication. So protected, the animals usually increase rapidly in numbers and the pelts are often of better quality than those caught in nearby areas which are purely untended. The scheme is likely to be rapidly extended because of the low cost and ease of producing pelts. Besides the private preserves of individuals and the Hudson's Bay Company, the Dominion has started a beaver reserve of this type for the Indians on the east coast of Hudson Bay. The province of Manitoba is following a similar plan with muskrats in the delta of the Saskatchewan river east of The Pas. It has already provided a livelihood for a number of trappers who had previously been on relief due to the virtual depletion of their hunting grounds.

An interesting but not very widely-used variation of the same plan is the leasing of islands off the coast of the Gaspé Peninsula for the right to collect the eiderdown with which the ducks and other birds line their nests. The lessee protects the breeding places of the birds in order to secure an income for himself. Incidentally, by guarding the breeding places of the birds he increases their numbers for the benefit of sportsmen. No leases of eiderdown rights have so far been granted in the Shield or in the Tundra, though the government encourages the natives to collect the down and thus secure a small supplementary income for themselves.

[51]Allan, D. J., "Wildlife in Relation to Soil Uses and Human Affairs", *Transactions, Canadian Conservation Association*, 1941, pp. 64-71; Bonnycastle, R. H. G., "The Hudson's Bay Company's Fur Conservation Plan", *ibid.*, pp. 96-102.

General

At one time the Shield was looked upon as a worthless waste of rock, muskeg, and water. Besides being economically valueless, it was an almost insuperable barrier to transportation and communication and divided the nation in two, politically and economically. Yet since 1920 this Region has become of vital importance to the Canadian economy.[52] Its mining and newsprint industries are world famous. The generation of hydroelectric power is of growing significance. The agriculture and fur trade of the Shield, though over-shadowed by other activities, are reasonably prosperous. In the course of time the population may even unite the eastern and western segments of Canada economically and socially. In the long run the Shield faces the danger that a large part of its prosperity will collapse with the depletion of its mineral resources. The fundamental problem of the Region is to build up alternative sources of income so that, when its mines are gone, its people may profitably turn to other occupations.

[52]Currie, A. W., *Canadian Economic Development*, Toronto, 1942, pp. 222-43; Mackintosh, W. A., "The Laurentian Plateau and Canadian Economic Development", *Economic Geography*, vol. 2, October, 1926, pp. 537-49.

Chapter VII

THE MACKENZIE VALLEY AND HUDSON BAY LOWLANDS

ADJACENT to the Shield are two districts—the Valley of the Mackenzie River and the Lowlands of Hudson Bay—which differ markedly from the Shield in topography and geological history but resemble it somewhat in certain aspects of their economic life. The Region of the Mackenzie Valley extends from the basin of Lake Athabaska over 1,000 air miles northwesterly to Beaufort Sea. It lies between the low Mackenzie Mountains of the Cordillera on the one hand and the hilly upland of the Shield on the other. Lakes Athabaska, Great Slave and Great Bear occupy part of the margin between the Lowlands and the Shield just as Lake Winnipeg and some of the Great Lakes do.

In appearance the valley is comparatively flat and is mantled with soil, a distinct contrast to the nearby Shield. There are many small lakes and swamps but on the whole these are less numerous than on the Shield. The broad Mackenzie, shallow in places, meanders across the valley. The Region is reasonably well covered with coniferous forests, especially along the river banks where the drainage is better than farther inland. The trees, though diminishing in size, continue to grow even in the upper Mackenzie delta. As one goes inland from the river, the vegetation gradually begins to resemble that of the Tundra.

The geological history of the valley is simple and resembles that of the Prairie Region, of which it is physiographically a part. Detritus was deposited on crystalline rocks like those of the Shield. In a few areas the rocks now exposed at the surface are

young, Tertiary and Cretaceous, but for the most part they are older. They are chiefly limestones and sandstones, with some slate. Some of the strata have been gently folded.

During the Glacial period the valley was invaded by the same continental ice-sheet as that which occupied most of the Prairies. This glacier over-rode the low Franklin Mountains, just west of Great Bear Lake and carried boulders and finer detritus into the valley proper. A few pro-glacial lakes similar to Lake Agassiz seem to have come into existence and were later drained away. The geological history was favourable to the formation of beds of salt and oil-bearing shales but not for precious metals.

The Hudson Bay Lowland[1] is a very flat plain bordering the southern shore of Hudson Bay and the western and southern shores of James Bay. It has a length of 800 miles along a south-east direction and a breadth varying from 100 to 200 miles. Its total area is larger than that of "old" Ontario south of Lake Nipissing. Its geological structure is almost identical with that of Southampton Island in the Arctic Archipelago and resembles the rest of the archipelago in a general way. Its vegetal cover is similar to that of the adjacent Shield.

The flat plain of the Lowlands dips gently toward the north-east and slips almost imperceptibly beneath salt water. In fact, the seaward margin is seldom well defined. "A strong wind from the sea may push the shore line inland half a mile or more from the position it occupied during a period of calm weather, while a breeze from the land may hold the flood-tide as far to the seaward of its average position."[2] At low tide the sea retreats from two to six miles from the high-tide shore-line, exposing a flat beach with slimy mud or green sea-water algae and pools

[1]Kindle, E. M., "The James Bay Coastal Plain", *Geographical Review*, vol. 15, April, 1925, pp. 226-36; Young, *op. cit.*, pp. 122-7.

[2]Nichols, D. A., "The Geographic Setting of Northern Ontario", *Canadian Geographical Journal*, vol. 18, March, 1939, pp. 147-51; Kindle, *op. cit.*, p. 230.

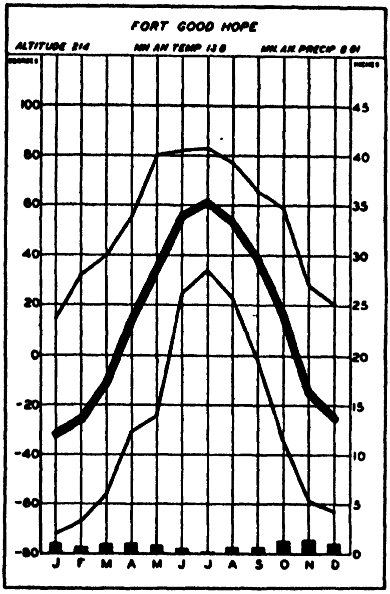
of salt water. Inland from this neutral zone of sea and land, there is a succession of narrow sandy strips, or beaches, divided by shallow swamps extending altogether for a width of about ten miles. Still farther in from the sea, trees begin to grow. At first these are straggling willows, small and dwarfed, but gradually they change to thicker stands of coniferous trees. The forest cover is often broken by small shallow pools and lakes and, frequently, even several miles inland from the coast, the soil is so waterlogged that trees will grow only near the larger streams.

In brief, the Lowlands are a very youthful plain. They have been formed so recently, geologically speaking, that the rivers have not had time, a matter of several million years, to erode their way deeply enough through the soil to drain all the area. Even after the passage of long periods of time, it is doubtful whether proper drainage will ever be attained along the coast because the gradient of the rivers is very low. It amounts to only a little more than three inches per mile on the lower Abitibi and Moose but increases fifty miles inland so that drainage improves and the forest covers the land more uniformly. Eventually the Lowlands merge with the Shield. Occasionally the junction of the two Regions is not clearly marked by relief but usually there is an abrupt drop down which rivers from the Shield descend in rapids to the gently sloping plains. In all cases the boundary is distinguished by a change from clay where outcrops of bare rock are rare to rock where the existence of deep layers of soil is exceptional.

Economic Activities

Agricultural development in the Mackenzie Valley is restricted by the climate which is similar to that of the adjacent parts of the Tundra and Shield. The summers are too short

for many cultivated plants to mature.[8] The top soil is frozen for at least nine months of the year and the sub-soil is permanently frozen. Cold water lies on much of the land during the summer. It is claimed that where artificial drainage and thorough cultivation have been practised, as in the vicinity of some



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of the trading posts, the sun's heat has been able to penetrate more deeply into the soil, the permanent frost line has dropped several feet, and hardy vegetables have a good chance of growth.

Despite difficulties, agriculture has been carried on at many

[8]Albright, W. D., "Crop Growth in High Latitudes," *Geographical Review*, vol. 23, October, 1933, pp. 509-20; "Gardens of the Mackenzie," *ibid.*, vol. 23, January, 1933, pp. 1-22; Finnie, R., *Canada Moves North* (Toronto: The Macmillan Company of Canada Limited, 1942), pp. 136-68.

centres in the valley for many years. In 1939, at Resolution on Great Slave Lake, tomatoes were harvested while still green and ripened inside. Two small crab-apple trees produced fruit which, though a little sour, was quite edible. Potatoes yielded at the rate of eight bushels for each one of seed. At Good Hope on the Mackenzie River, near where it crosses the Arctic Circle, cereals failed to ripen but many vegetables were grown. Even at Aklavik in the Mackenzie delta, 1,330 miles north of the 49th parallel, potatoes the size of hen's eggs, lettuce, radishes and carrots are grown regularly and good-quality oats are produced in more favourable years.[4]

The same general conditions with respect to agriculture apply to the Hudson Bay Lowland. For many years a missionary on an island near the mouth of the Moose River has been able to raise all the hardy vegetables which he and his family need, and provide ample fodder for a cow. No one believes that crops can be grown generally throughout the area. They are necessarily confined to a few sites with favourable soils, good exposure to the sun, some protection from the winds, and complete freedom from fires which destroy the humus in the soil. These sites should be used as much as possible. Home-grown vegetables would afford a welcome change in the diet and save the high transportation charges which would otherwise have to be paid to bring the articles in from outside. Agriculture on a limited scale and for partially fulfilling local needs is both feasible and desirable.

Both the valley and the Lowlands have mineral wealth of potential value. Petroleum is obtained in the vicinity of Norman on the Mackenzie, near the sixty-fifth parallel.[5] Most of the output has heretofore been sold to the radium mines near the

[4]*Annual Reports* (Dom. Dept. Agric.), *passim.*

[5]Allan, J. A., "Mineral Development North of 54 degrees", *Engineering Journal*, vol. 23, June, 1940, pp. 274-80.

eastern end of Great Bear Lake. More recently a pipe-line several hundred miles long has been built to connect with the Alaska Highway at Whitehorse, Yukon Territory, where a refinery has been erected. These facilities have reduced the price of gasoline along the Highway by no less than 90 per cent. The Norman field is exceedingly important because it gives a supply of relatively cheap fuel to some districts which would otherwise be isolated from sources of gasoline for planes and of fuel oil for use in tractors, mines, and river vessels.

One of the world's largest resources of oil-bearing sands flanks the Athabaska River and some of its tributaries near McMurray[6] for a total distance of 260 miles with rich concentrations for at least 50 miles. The sands vary in thickness from a few feet to 225 and have a bitumen content of from 1 to 20 per cent by weight. Their total volume has been estimated at between 35 and 100 cubic miles but the sands are not homogeneous, lean bands being scattered among the richer. Estimates of the potential supply of petroleum vary widely from one authority to another, but Moore estimated in 1927 that if the extracted bitumen were even equal to 5 per cent of the rock, the reserve would equal the world's annual output of crude oil for 130 years. Because the known resources of petroleum derived from wells are being depleted at a truly alarming rate, this reserve in the sands is likely to be of increasing importance.

The petroleum is present as a thin film enveloping each grain of sand. It can be removed by evaporation while dry or by washing with boiling water. The sands can be dug up cheaply by machinery. Unfortunately, the problem of economically extracting the petroleum from the sands is not yet solved and the cost of petroleum products obtained by the methods now in use

[6] Ells, S. C., "Bituminous Sands of Alberta", *Canadian Geographical Journal,* vol. 6, April, 1933; Ells, S. C., and Swinnerton, A. A., "Bituminous Sands of Northern Alberta", *Trans. C.I.M.M.,* 1937, pp. 629-48; Moore, *op. cit.,* pp. 212-3.

is higher than the price of imported gasoline and fuel oil. The sands themselves and the bitumen extracted from them have been used for many years on roads in Alberta but until new and cheaper processes are discovered, the sands have merely potential value as sources of gasoline and lubricants.

Near McMurray there has also been discovered an enormous reserve of good-quality salt. Coal also outcrops along the banks of the lower Mackenzie. One seam was observed burning by Sir Alexander Mackenzie in 1789 and continues burning to this day.

Coal has also been discovered in the Hudson Bay Lowland, 125 miles north of Cochrane.[7] It exists in two more or less parallel seams separated by a layer of sand and mud. The upper seam has an average thickness of 25 feet, covers one and a half square miles, and is buried 172 feet below the surface. It is claimed that the seam could be mined by open-pit methods. Power shovels would dig up the overlay which would be hauled away in cars operating on light railways. Then the coal would be removed in the same way. No heavy timber would be required for support as in subterranean mining. Natural ventilation would be secured and there need be only a relatively short interval between initial investment and maximum daily production. Open-pit mining can be carried on for eight or nine months each year. Unfortunately, the lignite is of low quality, sometimes being classified as woody, peaty, and earthy. Roughly half its total weight is water compared with 5 to 8 per cent moisture in fair-grade bituminous. Although the water can be eliminated by various means and the lignite improved until it is equal in thermal content to even anthracite coal, the present

[7] "Northern Ontario Lignite", Ontario Research Foundation, *Bulletin*, vol. 1, 1934, *passim*.

processes for doing this are quite expensive. Until much cheaper methods are devised, Northern Ontario lignite is not likely to be of any commercial value.

Like the adjacent parts of the Shield, these two plains are important in the fur trade. Their forest wealth is of only local significance. The trees are moderately satisfactory for use as fuel and for building purposes in the immediate area but will be of no commercial importance to Canada as a whole.

CHAPTER VIII

THE TUNDRA

THE boundaries of this Region do not coincide with the limits of any one physiographic area. Up to the present, we have used physiography as the basis for the division of Canada. This plan was satisfactory for lending unity to each particular Region and distinguishing one Region from another as far as the rest of the Dominion was concerned, but as one goes farther north the physiographic basis is less acceptable for the reason that the climate, types of flora and fauna, and the economic activities which characterize the northern sections are only slightly related to relief. Without going into the ramifications of the problem, let us admit frankly that the Tundra Region has little physiographic uniformity. It is marked off from the other regions of Canada primarily by its vegetation and the character of its economic life.

The southern boundary of the Tundra Region is determined by the line along which forest vegetation dies out and the shrub-like or low-lying flora typical of polar regions begins. Generally, this boundary coincides with the isotherm (line of equal temperature) of 50 degrees Fahrenheit during July. This isotherm runs from just below the delta of the Mackenzie River to Churchill, Manitoba. On the east side of Hudson Bay the area north of this isotherm includes the upper quadrant of Ungava, the Labrador coast and a narrow strip along the straits of Belle Isle where the cold current from the north brings about Tundra conditions.

It must be emphasized that this line is only an approximate boundary. Biological species do not change from one broad type to another at any particular line but rather disappear grad-

ually. The boundary between biotic areas is a zone along which two types of vegetation—in this case trees and Tundra—blend until finally one predominates over the other. Between the actual Tundra and the dense forest extends a wide belt of mixed type where the trees are dotted singly or in clusters, seldom in close formation. Forests sometimes fringe the larger rivers, such as the Mackenzie, almost to their mouths but back from the river banks tundra-like vegetation prevails.

The eastern and western boundaries of the Tundra are, as far as Canada is concerned, the sixtieth and one hundred and forty-first meridians of west longitude, excluding Greenland. Canada has officially laid claim to all this triangular sector as far north as, but not including, the North Pole. She maintains permanent police patrols at several points in this territory in order to substantiate her claims in the eyes of international law. No land is known to exist beyond 83 degrees north.

Topography

The Tundra incorporates all of one physiographic province, the Arctic Archipelago, and the northern sections of another, the Shield. There is no need to describe again the geology and topography of the Shield except to emphasize that, different as it is from the archipelago structurally, the native vegetation and characteristic economic life of the upper arms of the Shield are broadly similar to conditions in the Arctic islands.

The archipelago,[1] excluding Greenland, has a land area of half a million square miles or one-seventh that of all Canada. Its width along the seventieth parallel is about 1,500 miles and

[1]Young, *op. cit.*, pp. 122-7; Canada's Eastern Arctic (Ottawa: Department of the Interior, 1934); Canada's Western Arctic (Ottawa: Department of the Interior, 1931); Keewatin and Northeastern Mackenzie (Ottawa: Department of the Interior, 1930); Robinson, J. L., *An Outline of the Canadian Eastern Arctic, its Geography, Peoples and Problems* (Ottawa: Dept. Mines and Resources, 1944); *The Northwest Territories, Administration, Resources, Development* (Ottawa: Dept. Mines and Resources, 1944).

from Hudson Strait to the northernmost point of land approximately the same distance. Baffin Island, the largest in the archipelago, is about the size of France.

Generally speaking the islands are a series of plateaus formed of strata gently dipping toward the southwest. Along the eastern coasts of Baffin, Devon, and Ellesmere islands a northern extension of the Canadian Shield gives an irregular broken coast-line. In many places the coast is fringed with small islands and rises abruptly to general elevations of 2,000 feet in the south, increasnig to 5,000 feet farther north. Behind this steep rim in Baffin Island a broad, uneven upland with a general altitude of 1,000 feet slopes gently downward to the west and southwest. The same general structure appears in all the more northerly islands, although they have higher elevations and, usually, precipitous mountains along their northern as well as along their eastern coasts. The southwest section of the archipelago, particularly Victoria Island, is comparatively low-lying.

During the winter the Region has the appearance of a flat, cold, waste land relatively thinly covered with granular snow and in perpetual twilight or darkness. With the approach of spring the days lengthen, the sun becomes warmer and the snow begins to disappear. Even while some snow is still on the ground, literally hundreds of acres of flowering plants burst into bloom. During the summer much of the land is covered with water which lies in pools until evaporated into the air or absorbed by plants. This condition is caused partly by the natural flatness of the land and mainly by the fact that the perennially frozen sub-soil prevents the melted snow from seeping into the ground. In most cold climates the existence of a deep blanket of snow acts as an insulator and thus reduces the depth of the layer of soil which is frozen during the winter but in the Arctic the snow cover is so light and the winters are so prolonged that the ground often freezes to depths of as much as sixteen feet. The summer's

heat never thaws out the top-soil beyond a foot or two. This thin layer is usually saturated with water throughout the summer and the Tundra assumes a fen-like appearance. Before many weeks of summer have passed the ice begins to form again and the frost of winter grips the land.

Geology

The geological history of those parts of the Shield which are included in the Tundra has already been explained. In the archipelago hard crystalline rocks of Precambrian origin outcrop along the eastern and northern borders and presumably underlie the rest of the Region. These rocks are of the same character as those of the Canadian Shield of which they are structurally the outliers. Like other parts of the Shield these rocks were eroded to nearly flat surface at a very early period. During the Paleozoic era the Precambrian base was partly covered by seas which seem to have occupied various positions at different times. Layers of sand, gravel, and the calcareous shells of marine animals were deposited in the seas upon the submerged Precambrian rocks, and subsequently formed strata of sandstone, conglomerates, and limestone. Broadly speaking, the oldest strata of Paleozoic origin outcrop toward the east and the more recent ones lie toward the western parts of the Region just as they do in the Lowlands of Ontario. In the Parry Islands beds of bituminous coal of the Lower Carboniferous period are present.

In the Mesozoic era small areas of limestone and limy shale were formed chiefly in the eastern archipelago. Later the sediments in some localities were faulted. Possibly the same orogenic movements were the cause of the long straits and sounds that now characterize the Region. In the Mesozoic era thick beds of sand and clay with layers of lignite were produced along the west coast of Ellesmere and in northeastern Baffin Island. Nevertheless the archipelago has had a relatively peaceful existence

ever since the Cambrian period. In the Pleistocene period the great ice-sheet covered the Region, as it did most of the rest of Canada, but the results of glacial action are not nearly so prominent in the archipelago as farther south. Since the Ice Age, the Region has been rising relative to the sea.

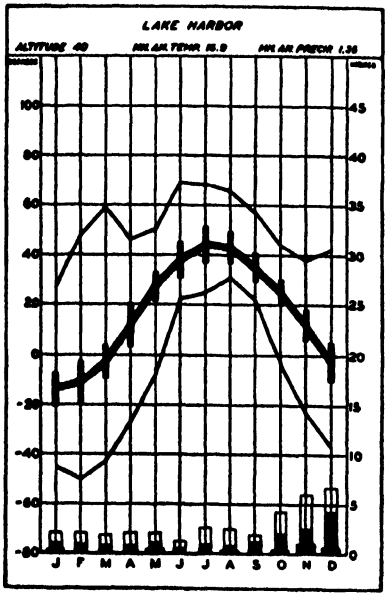
The geological history and topography of the Tundra have had comparatively little effect on economic development, chiefly because commercial activity has been slight. Agriculture, as that term is commonly understood, is non-existent, although the Tundra may have a great potential value as a pasture land for reindeer, caribou and musk-oxen. Minerals in the upper arms of the Shield are already being exploited in a limited way and the coal measures of parts of the archipelago may be possible sources of wealth in the far-distant future. For the present, economic activity is confined to the trapping and hunting of fur-bearing animals and is mainly in the hands of aborigines with people of European descent handling the trade. In this development, the dominating factor is climate, not topography, soil, or minerals.

Climate

The Tundra Region covers such a huge area that any brief description of its climate[2] is necessarily inaccurate in detail. Along the southern boundary there is little to distinguish the climate of the Tundra from that of the Shield, already described. Generally as one goes farther north the climate becomes more severe. This does not mean that the temperatures invariably reach lower minima than they do elsewhere in Canada nor that hot weather is not experienced during the summer.

[2]Connor, A. J., "Temperature and Precipitation in Northern Canada", *Canada Year Book, 1930*, pp. 41-56; Nordenskjöld, O., and Mecking, L., *The Geography of Polar Regions* (New York: American Geographical Society, 1928); Weyer, E. M., *The Eskimos, Their Environment and Folkways* (New Haven: Yale University Press, 1932); *Meteorology of the Canadian Arctic* (Ottawa: Dept. Transport, 1944).

The January average at Herschel Island off the mouth of the Mackenzie is 22 degrees Fahrenheit below zero and the lowest temperature ever recorded was 52 degrees below zero. Absolute minima lower than this have been recorded in both Montana and North Dakota. At Good Hope in the forest of the Mackenzie Valley but near the Tundra the official absolute minimum was



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(NOTE: *Lake Harbor is on Baffin Island just north of Hudson Strait.*)

79 below, with a January average of 23 below. Temperatures equally cold have doubtless been experienced though not officially recorded elsewhere in the interior of the Tundra. The cause of slightly higher winter temperatures on the coast than inland is that the littoral is warmed by the influence of the nearby sea.

This may seem strange, for the temperature of the Arctic ocean is always close to freezing. Even so, during the winter the sea is warmer than the adjacent land and the winds blowing from it tend to keep the weather along the coast milder than it would otherwise be.

Of course, low winter temperatures persist for long periods of time. Average temperatures below zero may be expected from November to April throughout much of the Region. It is this fact of persistence rather than one of degree which chiefly distinguishes the winters of the Tundra from those immediately to the south. In the Prairies the cyclonic storms occasionally bring relief from cold weather. Also the conflict of polar and warm air masses forces the polar front farther north or south in some years than in others so that exceptionally mild winters are interspersed with "arctic" ones. On the Plains a "spell" of cold weather may force the temperature to lower levels than it ever reaches in the Arctic but it is not likely to stay at that very low level for more than a few days at a time even in the "arctic" winters. In the Tundra, cyclonic storms are rarely present; the area is steadily under the polar air mass and so the winter cold is more continuous than toward the south.

In the summer high temperatures sometimes occur in the Tundra. At Good Hope the highest maximum ever recorded was 95 degrees and the average temperature of the warmest month, July, is 61.2 degrees, nearly the same as June in Montreal. Along the coast the ocean, which is now cooler than the nearby land, keeps the littoral a little cooler than places 100 miles or more inland. The interior of the archipelago is undoubtedly the coldest part of Canada in both summer and winter.

The fact that July temperatures in the Tundra are so high in comparison with the winter averages is due to the long periods of sunshine during the summer days. The reception of heat from the sun is almost continuous and partially compensates

for the shortness of the summer season. On the other hand, the sun's rays strike the earth at high latitudes at a very acute angle. They must pass diagonally through a thick blanket of air before reaching the earth's surface and more of their heat is lost in the upper atmosphere than is the case where the sun is more directly overhead. In addition each ray must, so to speak, spread itself over a broader area because of the curvature of the earth. The temperature of any point on the earth at a particular time is basically determined by the daily duration of sunlight and the angle at which the sun's rays fall. In the Arctic these two factors work in opposite directions. Even so, almost as much heat is received at the surface of the earth in the Arctic on mid-summer day (June 21) as at the Equator. Unfortunately, the period of almost continuous daylight is not long and for the rest of the year the amount of insolation is negligible. Moreover, so much of the sun's heat which does arrive is "applied directly to melting the snow and ice, thawing out the frozen surface and evaporating water from the thoroughly soaked ground that the surface and the air in contact with it do not become very warm. As soon as the sun sinks beneath the horizon, the temperature falls rapidly. Though the days may be warm, the nights are cold even in summer."

The long winter is not only cold but dark. The short summer is filled with sunshine as well as being moderately warm. At latitude 70 degrees north, close to the Arctic coast of Canada, the sun does not appear above the horizon between November 25 and January 18. Nevertheless, this period is not one of Stygian blackness. The moon, stars, and at times the spectacular auroras give light for intermittent hunting and fishing. The sun is never far below the horizon for part of this time and there is a kind of twilight for a few hours each day. As the sun begins its apparent journey northward, the twilight gradually lengthens and true sunlight appears. On March 21 the sun attains a

maximum elevation above the horizon of 20 degrees, and there are 12 hours and 20 minutes of sunlight. The hours of daylight increase until from May 17 to July 28 the sun is above the horizon at all times. Gradually the sun reaches lower elevations in the sky and the hours of daylight shorten. On September 21 the conditions of the vernal equinox are repeated and in November the winter night begins. At latitude 80 degrees the periods with "midnight suns" and with no suns at all are each two months longer than at 70 degrees, with the intermediate seasons correspondingly shorter. At 60 degrees the sun is never above the horizon for twenty-four hours at one time. From May 21 to July 21 the duration of possible sunshine is over 17½ hours, while from November 21 to January 21 it is always less than seven hours.

Precipitation in the Tundra is uniformly light, being under 10 inches except along the southern margins. Evaporation is very low because the air, due to its low temperature, cannot absorb much water vapour. If evaporation were as great in the Arctic as it is in the horse latitudes we would have dry deserts in the north as well as in the sub-tropics. Even as it is, Arctic plants have to make special adaptations to overcome deficiency of water in easily assimilable form.

Usually precipitation occurs in every month of the year, with a slight tendency to a summer maximum. Snowfall is light, rarely exceeding two feet. Normally it comes in the form of minute spicules which pack much more solidly together than the fluffy flakes of Eastern Canada. Fogs sometimes occur along the coast when the relatively warm on-shore winds blow over the colder land or vice versa.

Flora and Fauna

Because the climate in the Tundra is quite different from that in other parts of Canada the flora is also distinctive and therefore

deserves special attention.[8] Botanically the Tundra includes the area north of the tree line, but the Region is by no means devoid of plant life except, perhaps, in a few hundred square miles west of Hudson Bay. The old expression, "the Barren Grounds", is slanderous when applied to the Tundra as a whole. There may be very good stands of trees in sheltered spots, especially along the river banks, but banksian pine slowly gives way to poplar and Richardson willow, the cover of trees thins out and in the archipelago, though a few trees are present they are gnarled and twisted. "Even when half a century old they reach an inconspicuous height compared with their next of kin farther south and are often prostrate or lying on the ground". At the same time the Tundra has about 250 species of flowering plants. Lupine, with its hyacinth-like flower, covers acres of land during the summer. Arctic heather, which for 50 weeks of the year is a green-brown mat of moss, is a mass of tiny white bells of bloom for two weeks in July. Sweet-scented ferns, hardy saxifrage, and dwarf bushes also cover large areas except in the more northern islands. Altogether the Tundra is not at all the barren waste of school geographies a generation ago.

Many of these plants show interesting adaptation to climatic and soil conditions. Practically all are perennials and, owing to the shortness of the season, may not have time to flower and develop seeds before being frozen. In other climates frost destroys growth; in the Tundra it only arrests it. Some plants literally hibernate in the fall with flower and bud in an advanced stage of development. When the temperature rises in the spring they renew their activity from the point where they have left off in the preceding year. Sometimes the buds are hidden at the base of the plant between the dead leaves, well protected from

[8]Klugh, A. B., and McDougall, E. G., "Faunal Areas of Canada", *Handbook of Canada* (Toronto: University of Toronto Press, 1924), pp. 208-9; Porsild, A. E., "Arctic Wild Flowers", *Canadian Geographical Journal,* vol. 1, May, 1930, pp. 83-95.

the killing evaporation of moisture during the dry winter. Long before the last snows have entirely vanished in the spring, the flowers bloom and the seeds begin to mature. Meanwhile, new buds are being formed ready for instant response to the mild weather of the following spring. In this way the plants are able to propagate themselves in spite of the short summer.

As already indicated, annual precipitation is light and much of it is in the form of snow. The water-absorbing parts of plants cease to carry on their functions when the temperature falls below a certain figure which, though it varies from one species to another, averages about 40 degrees Fahrenheit. In the Tundra the amount of water with this temperature or higher at any time of the year is strictly limited. Although during the summer there is plenty of water lying in ponds above the frozen sub-soil, there is a scarcity of moisture in assimilable form. In fact, moisture conditions are somewhat similar to those in hot deserts and plant life in the Tundra shows desert or xerophytic adaptations. Tundra plants store up water within themselves so as to resist the evaporation which would otherwise take place in winter when the air is very dry. By storing water, the plant has enough on hand to begin growth in the spring as soon as the temperature above the ground is suitable and even before the root system has completely thawed out. Many sub-arctic plants have leathery leaves and grow in compact bunches or mats in order to reduce loss of water by transpiration. Unlike their sub-tropical counterparts, Tundra plants are never spiny or thorny, evil-smelling or poisonous since there is not the same need to protect themselves against grazing animals which, by eating up almost all the plants and seeds, might prevent regeneration of the species.

The native animal life includes lemmings, hares, foxes, caribou, and, farther north, polar bear and musk-ox. These are not numerous when the size of the Region is considered but are important from a commercial standpoint. In the summer there

are thick clouds of mosquitoes and black flies. Although these are an infernal nuisance to man, they provide an inexhaustible supply of food for large numbers of birds. For obvious reasons almost all the birds are migrants. Many of them are waders like plover and heron, while others—ducks and geese, for example—are swimmers.

Eskimos

The original and still the most numerous settlers of the Arctic coast in the Northwest Territories and Quebec, the more southerly parts of the Archipelago and some of the islands in Hudson Bay, are the Eskimos.[4] On the southerly parts of the Tundra there are some Indian tribes who spend the summer on the Tundra and the winter in the coniferous forests. There are also a few hundred people of European descent, chiefly traders, trappers, miners, missionaries, doctors and government officials. Due to the obvious inhospitality of the Region, it is unlikely that the white population in the Tundra will ever be numerous or perform more than trading, teaching and administrative functions. Pre-eminently the Tundra is the land of the Eskimo. The economic future of the Region depends fundamentally on their character and ability. Moreover, they have shown an adaptation to their environment that is exceptionally effective and illustrates the influence of climate and other geographic factors on human activities.

[4]Banting, F. G., "With the Arctic Patrol", *Canadian Geographical Journal,* vol. 1, May, 1930, pp. 19-30; Brown, R. N. R., *The Polar Regions* (London: Methuen & Co. Ltd., 1927), pp. 146-56; Ekblaw, W. E., "The Polar Eskimos", *Annals of the Association of American Geographers,* vol. 17, December, 1937, pp. 147-98; Finney, *op. cit.,* pp. 182-90; Jenness, D., *The People of the Twilight* (New York: The Macmillan Company, 1928); "A New Eskimo Culture in Hudson Bay", *Geographical Review,* vol. 15, July, 1925, pp. 428-37; Stefansson, V., *My Life with the Eskimo* (New York: The Macmillan Company, 1918); Weyer, *op. cit.,* Robinson, J. L., "Eskimo Population in the Canadian Eastern Arctic", *Canadian Geographical Journal,* vol. 29, September, 1944, pp. 1-16.

Like all primitive peoples, the Eskimos are concerned with the immediate problems of securing food, clothing and shelter. They live entirely on animals with the exception of a few leaves of scurvy grass for flavouring soup, tea brought in by traders, and, for some natives, the bitter contents of the storage pouches of the caribou. A few groups may also have access to blueberries, salmon berries and some tuberous roots (Eskimo potato) but the regular diet of all these aborigines is supplied by ringed seal, the meat of which is said to be greasy, dark, and fishy, but sweet and palatable. The narwhal, polar bear, and walrus provide supplementary food dishes. Caribou is a luxury to most Eskimos in the archipelago though it is hunted regularly by those on the mainland.

When an animal is caught, the liver, heart, kidneys, and brains are always consumed raw. In this way the native secures adequate supplies of vitamins which people in more favoured climes secure from fresh vegetables, milk, and eggs—foodstuffs which are not available to Eskimos. Much of the flesh of the animal is also eaten raw because fuel is scarce and the stone pots heretofore in general use cannot be heated economically. Only about half the meat is cooked. Roasting is impossible where the only "stoves" are shallow soapstone bowls burning blubber. Even to boil meat is a slow, inefficient process. Almost every part of the animal is put to some use either as food for humans or dogs, or for clothing and weapons. The means of livelihood are limited and resources must be used thriftily.

Dovekies, birds about the size of a robin but otherwise resembling ducks, are dexterously caught with nets by women and are eaten whole—viscera, bones, and meat, except bill, feet, and feathers. Some food secured during the summer is stored for winter use because refrigeration is easy and the natives do not object to meat that is "high". For the most part the Eskimo family is dependent for food on what the hunter currently brings

in. Hunting methods vary from season to season and the family moves frequently in order to get an adequate diet and the necessary variety in skins and furs for the different articles of dress. Hunting, the main occupation of the adult males, is exceedingly important because the family depends upon it for both food and clothing.

The clothing must be warm and durable and formerly had to be made entirely of local raw materials since there were no trading connections with other regions. As a matter of fact, clothing of the type used in cold temperate climates such as the Prairies is less suited to Arctic conditions than that produced by what appear to be primitive methods by the natives themselves. Leather tanned in the ordinary way becomes cold, brittle and stiff under continuous sub-zero temperatures. Eskimos prepare their leather by chewing, an almost unending task for girls and women from the age of four or five until their teeth are worn down to the gums at about the age of 45. Such leather is always soft, warm and pliable no matter what the temperature may be. Particular attention is paid to the leather which goes into the shoes because a person, especially a hunter, with frozen feet is worse than useless in this climate. The shoes are made of selected seal skins, carefully chewed. They are held firmly to the feet with a thong tied securely above the instep to prevent the shoe from turning and wearing quickly through along the seam between the sole and the upper. In the eastern Arctic trousers for the men and women are made of seal skin or caribou. Fox skins, being comparatively poor wearing, are rarely used for native clothing. The upper garments of both sexes are made of young seal skin, with the head of the animal being used to cover the head and ears of the wearer. In winter undergarments made by sewing together the soft feathery breasts of dovekies and eider ducks are worn. In the western Arctic men's trousers and indeed much of the clothing of both sexes is made of caribou skin, which

is warm and lightweight. In the very cold weather two suits are worn, one with the hair inside and the other in the opposite way.

Sewing is done with needles from the split bones of the hare or gull and thread of the flank tendons of the caribou and narwhal. The "thread" has the advantage over linen of swelling when wet, thus filling up the holes made by the needle and making the garment watertight. The Eskimo takes particular care never to allow his shoes or garments to become wet by snow melting on them. If he did not do this, the moisture would freeze when he went outside again and he would get very cold. Those Eskimos who regularly come in contact with Europeans, especially those near the mouth of the Mackenzie, are adopting more and more the clothing of the whites. It is claimed that the portable type of sewing machine is becoming a common article of equipment.

Usually the Eskimos live in villages scattered along the coast. In this way there is no congestion of hunters and there is a greater likelihood that food will be available for all. Summer villages are located on some fairly level place near haunts of land animals and on open water where the sea hunting is good. During the summer the natives live in tents made of skins which have been tanned by scraping and beating but not chewed, because great pliability is not essential. The skins are stretched over poles 7 or 8 feet high at the front and slope downward toward the back. The tent occupies a space of about 15 by 12 feet.

Villages for winter use are set up where there is some protection from cold windstorms. They must also be close to good hunting grounds and near smooth, sound ice to allow safe and easy sledding. In the western Arctic, the walls and floors of the winter homes or igloos are of stone, the roof being covered with the skins from the summer tent. The approach to the igloo is a low vestibule 10 to 30 feet

long covered with mossy turf and usually occupied by snarling dogs. The igloo is warmed by a stone lamp filled with blubber from walrus or seal and with a wick of dried moss. Good ventilation is secured by means of a hole in the roof. Since the stone house is not occupied during the summer and the roof is removed then, air and sunshine are able to enter, making the habitation thoroughly wholesome for winter occupancy. In the west igloos of snow, familiar to the general public, are temporary structures erected for over-night stops along the trail. In the eastern Arctic, however, the snow igloo which "is a unique triumph of human skill over stern necessity and want of resources" is the typical winter dwelling.

Travel in summer is by boat, and in winter by dog-team. The usual type of cruising boat is an open whale-boat to which a sail is attached. If the owners can afford it, the boat is equipped with a gasoline engine. Eskimos, with a little coaching, are good mechanics. Three or four families with all their dogs and equipment are likely to travel in the same boat. The smaller, one-man kayak is still used extensively for hunting and travelling. It is made of driftwood strongly laced together with thongs. The hull and deck are covered with sealskin except for a hole in which the hunter sits. The vessel, which is long and narrow and propelled by a double-bladed paddle, is quite seaworthy. The winter sledge or komatik used in the eastern Arctic will support loads of 1,000 pounds or more. It is pulled by dogs—huskies—wearing leather harness and commonly hitched to the komatik in a fan-like manner, though occasionally tandem. The dogs are fed usually on walrus or seal meat. They are hardy and willing. Because of their importance in carrying the native and his supplies across the ice to hunting grounds and in hauling back the seals, bears, and other game, the huskies are well cared for by their Eskimo masters.

It is clear that the Eskimos have a high degree of culture in the sense that they have effectively adapted themselves to their environment. Unfortunately this culture is being destroyed by contact with the white man. Diseases such as influenza, tuberculosis and even measles brought in from outside are often fatal because the natives have not built up any natural resistance to them. The white man insists that the native bring him skins, especially the white fox. In exchange the Eskimos get gaudy woollen and cotton fabrics, or sea-biscuits and other exotic foods. The textiles are quite unsuitable and the foods if used for any period of time lead to a breakdown in the natives' health because they are deficient in vitamins which the white man ordinarily gets from vegetables and the native typically from raw meat. The value of furs varies with changes in fashion and the fluctuations of the business cycle. Moreover, for some reason the numbers of lemming, a mouse-like animal, on which the Arctic fox mainly feeds, fluctuate in about a four-year cycle. The number of foxes which are the chief article of trade fluctuates too. The main source of income for the natives is thus an uncertain one. Hunting, the very centre of the economic life of these regions, is now concerned with catching foxes for sale rather than other animals for food and clothing. As the Eskimo is drawn more and more into the commercial economy of the white man he tends to lose some of his old culture. Should the value of fox skins become depressed, the native loses his new source of income and, because he has forgotten some of his old knowledge, he is not well fitted to go back to his original way of life. Altogether, contact with the white man is of doubtful value to the native.

Due to the shift in economic life from self-sufficiency to dependence on trade with outside centres, the people have tended to re-locate their villages near where white foxes can be caught or where trade can be carried on or at administrative centres

like Pangnirtung on Cumberland Sound, Baffin Island.[5] Sometimes these new villages are remote from the main sources of the animal foods of the natives. Usually the animals which are near these new and larger centres of population are quickly exterminated by the white man's rifle. Food becomes inadequate. Also, when villages are continuously occupied, sanitation becomes more difficult and the health of the natives suffers. Finally, regular contact between the natives and the "advanced" whites in these villages and indeed throughout the territory as a whole raises numerous sociological difficulties. These have their counterpart in the relations between the whites and the Indians in the rest of North America, and between Europeans and the coloured peoples in other parts of the world. If the mistakes of the past are to be avoided with the Eskimos in the Tundra, a careful study of the ethnic problems is essential.

Fur Trade

The commercial importance of the Tundra to Canada is restricted to a few products, mainly furs.[6] Among the Eskimos furs are a necessity of life while to most other Canadians they are luxuries for the well-to-do. All the furs produced in the Tundra are obtained by stalking and trapping. The number of pelts seems to be declining slowly and their value, especially that of the chief product, the white fox, fluctuates a great deal from year to year due to changing conditions in the market. White traders in the Region being mainly interested in quick, cash profits, at times encourage natives virtually to exterminate all the animals in a certain district in order to get them. When the whites move on, the natives whose permanent homes are in the Tundra are left stranded without any source of income.

[5]Adams, J. Q., "Settlements of the Northeastern Canadian Arctic", *Geographical Review*, vol. 31, January, 1941, pp. 112-26.
[6]*Op. cit.*, Dept. of Interior, *passim*; Finnie, *op. cit.*, pp. 26-37.

Eskimos and the nomadic Indians are beginning to adopt the white man's attitude. The basic philosophy of the native has been to shoot all animals on sight because in a land in which food is never too plentiful at any time, "when meat is at hand, one must eat". So long as only primitive hunting methods were used, the work of stalking and killing the animals was so laborious that enough survived to perpetuate the species. Also the Eskimos appear to have adjusted their hunting to the animal population. As soon as the animal resources in a particular district indicated depletion, some families moved on to a new village. This conservation of resources by the Eskimos was not due to any superior insight on their part or any moderation of their desire to kill. Instead it is accounted for by the fact that when animals become scarce they are harder to secure. Whenever the Eskimo believed that he could hunt more easily outside the district adjacent to his present village than within it, he migrated. The use of high-powered rifles has completely changed this condition. The nicely adjusted balance between nature and man is quickly upset with disastrous effects on the animal population of the Region.

The Dominion government tries to prevent the wholesale destruction of one species by prohibiting hunting of one or other animals during a closed season but it is almost impossible effectively to enforce these regulations over such a wide territory. Besides, many of the animals provide the natives with necessary food and to forbid their capture may involve serious hardship. Accordingly some of the ordinances relating to animals apply only to white trappers.

Another attempt at conservation by the government is the establishment of game preserves in which all hunting is prohibited. The original idea was to protect the animals, especially musk-oxen and buffalo which were nearing extinction, until their numbers had again become sufficiently large so that they

could be freed to populate a wide area and hunting them could be thrown open without fear of exterminating the species. It has been found that numbers increase rapidly but after a few years the animals become so fearless of men that they would be quite helpless if freed. The government is able to sell meat and hides from the surplus animals in the preserve but never can restore the original conditions of wild life and normal hunting.

Agriculture

The Tundra is important as a potential food reserve.[7] Professor J. Russell Smith of Columbia University, Stefansson the Arctic explorer and others have popularized the Tundra as an area with several million square miles suitable for reindeer grazing. These enthusiasts have estimated that Arctic Canada could feed thirty million head of reindeer and produce ten million carcasses per annum. This exceeds the number of beef cattle brought to market in the United States in a year but a deer's carcass is only one-third as large as that of a fair-sized beef. If developed, the industry would make use of large areas of the Tundra now practically worthless. It would provide a good income of meat, milk, hides for clothing, bedding and tents, and draught animals to the Eskimos and Indians, and, if the meat could be sold in the south, a cash income as well. The herd itself would provide the essentials of life to the men in charge of it and so there would be no need to bring in at great expense large quantities of food and other supplies for the herders, as must be done now for northern miners.

[7]Smith, J. R., "The Reindeer Industry in America", *Scottish Geographical Magazine*, vol. 40, March, 1924, pp. 74-88; Stefansson, V., *The Friendly Arctic* (New York: The Macmillan Company, 1943); "The Canadian Government's Reindeer Experiment", *Canada Yearbook, 1943-4*, pp. 17-23; Stefansson, V., "The Colonization of Northern Lands", *U.S. Yearbook of Agriculture, 1941*, pp. 205-16.

Against this enthusiasm is the opinion of other experts[8] who feel that reindeer grazing in northern Canada is going to be of but limited importance. During the summer the reindeer feed on herbs, shrubs, and grass which grow in abundance. In the winter the principal fodder is mosses and lichens, which grow very slowly and are easily destroyed by trampling or close cropping. Due to the existence of plenty of summer feed there is a temptation to increase the size of the herd and over-graze the winter pastures. These pastures recover slowly and if badly used may take from 15 to 20 years to rehabilitate themselves. It is on this account that herds of native caribou and musk-oxen roam widely over the Tundra and follow different migration routes each year.

Another difficulty with reindeer raising is that the Eskimos and nomadic Indians are accustomed to the exciting life of the hunter and are unprepared to settle down to herding animals. They are also enjoying a great prosperity from the sale of furs and, brief though it may be, they are unwilling to forsake it for the prosaic and less profitable life of the herder. Sometimes, too, the primitive urge to kill all food on sight becomes too strong and the animals are slaughtered needlessly. Finally, if sale in southern markets is contemplated the problem of transportation and of competition with beef, mutton and pork becomes important.

In an effort to accumulate a fund of experience, build up a

[8]Anderson, R. M., "The Present Status and Future Prospects of the Larger Mammals of Canada", *Scottish Geographical Magazine*, vol. 40, November, 1924, pp. 321-31; Brown, R. N. R., "Some Problems of Polar Geography", *Scottish Geographical Magazine*, vol. 43, September, 1927, pp. 257-80; Porsild, E., "The Reindeer Industry and the Canadian Eskimo", *Geographical Journal*, vol. 37, July, 1936, pp. 1-19; *Reindeer Grazing in Northwest Canada* (Ottawa, Dept. of Interior, 1929); Seeman, A. L., "Development of Reindeer Activities in Alaska", *Economic Geography*, vol. 9, July, 1933, pp. 292-302; Wolfganger, L. A., "Economic Regions of Alaska", *ibid.*, vol. 2, September, 1926, pp. 508-36; "Insulted and Injured", *Scottish Geographical Journal*, vol. 53, September, 1937, pp. 297-306.

breeding stock for coming years and perhaps be of some help to the natives of the Tundra in the immediate future, the Dominion government has begun reindeer ranching on an experimental basis. After prolonged study by trained botanists familiar with conditions in the Tundra, a range was selected on the east bank of the Mackenzie near its mouth. The pasture is good and the range, being near the coast, is accessible to the bulk of the native population. It comprises about 6,000 square miles capable of supporting 25,000 head and is administered from near Kittigazuit, 40 miles east of Aklavik. A herd of about 3,000 reindeer was purchased in Alaska and driven overland by experienced Lapp reindeer herders. After a difficult six years' trip the herd was delivered at Kittigazuit in 1935. Since that time it has increased in size. Meat from the surplus stock is now being given to mission hospitals and residential schools in the Mackenzie delta. The training of young natives in reindeer work is proceeding steadily and, it is claimed, satisfactorily. During the summer the herd is driven toward the sea coast. Better pasture is secured and the winds from the nearby Arctic ocean give relief from some of the insects which make life unbearable for man and beast all over the Tundra.

The potential reindeer grazing land is not limited to the existing pasture at Kittigazuit. Another reserve of 10,000 square miles has been surveyed farther up the Mackenzie and one of 38,000 square miles staked out north of Great Bear Lake. Still other ranges are available along the west coast of Hudson Bay. These areas are not at present being used because of the shortage of stock and herders, the fact that most of the natives are near the coast, and the cost of transporting the meat from these ranges either south to thickly-settled lands or northward to the Eskimos.

It must be emphasized that only a small part of the Tundra is suitable for continuous reindeer grazing. Lichens will not grow on much of the area due to excessive cold, prolonged ex-

posure to frigid winds, or the presence of lakes and ponds. Elsewhere lichens appear only in such small and scattered patches that grazing is impracticable.

The comparisons so often made between the potential reindeer pastures of Canada with the ones actually in use in Alaska and Finland (Lapland) are not entirely valid. In Alaska the climate is a little more moderate than in corresponding latitudes in Canada. The valleys are more sheltered because they trend generally southwest to northeast and are bordered by high mountains. Some of the cold northern winds are excluded by the mountain barrier and the warmer winds from the Pacific can penetrate into Alaska more easily than they can into the northern parts of Canada which lie behind mountains and the Yukon plateau. As a result the grasses and lichens are more luxuriant and the carrying capacity of the ranges higher. In the Tundra of Finland where the reindeer are the real centre of economic life, the climate is more temperate than in the Canadian Tundra due to the influence of the Gulf Stream. Nevertheless, provided the hardier Siberian or Alaskan reindeer are introduced instead of the more domesticated Lapland variety and provided the herders are competent, there is no reason why reindeer raising will not develop in both the eastern and western Arctic. The reindeer population which could be supported is less per square mile than over-enthusiastic individuals believe and smaller, relatively, than in Alaska and Finland.

Another animal of potential importance is the musk-ox. This creature is heavy, solidly built, and has a coat of long, smooth, brown hair, with a heavy undercoat of wool. Stefansson believes that musk-oxen could be domesticated and bred for meat and wool. Although musk-oxen wool has many of the qualities of merino and weaves into cloth softer than cashmere, it is doubtful if it could be produced like ordinary wool, since shearing would leave the animal vulnerable to cold and mosquitoes. Musk-oxen eat grass and willow shoots at all seasons whereas deer eat

herbage and shoots in the summer and mosses and lichen in the winter. It will be recalled that the number of deer is limited by the scarcity of lichens. To avoid over-grazing the latter pastures, some grass and herbs go to waste when only reindeer are raised. These grasses could be used by musk-oxen and the raising of deer and musk-oxen could supplement each other. Difficulties such as the existence of lake and barren rock over much of the area, the training of herders, and transporting the meat to market exist for musk-oxen as they do for reindeer.

Musk-oxen have only one natural enemy, the wolf, and to protect themselves the herd forms a solid block, heads facing outward. The animal pays no attention to a rifle shot which sounds like the crack of ice to them. Hunters were often able to slaughter most of a herd one after another before the remainder got enough presence of mind to flee. The herds have been gravely depleted and the animals have been pushed back into the remote parts of the archipelago. The Dominion government has set up sanctuaries to prevent complete extermination of a valuable animal and shooting them, even by Eskimos, is forbidden.

Another possible food resource, the caribou, is really a native American variety of the European reindeer and eats the same types of food. It migrates in great herds in its search for good pasture, usually coming south in the winter. The Eskimos along the coast and the Indians hunt the caribou diligently, using the skins for clothing, bedding and tents and the meat as food for themselves and their dogs. The number of these animals also seems to be declining.

To sum up, it is possible that reindeer and the indigenous musk-oxen and caribou may eventually constitute a source of income, clothing, and food to the natives of the Tundra and a potential food supply to the people farther south. Unfortunately, the sale of meat outside the area is limited by the cost of transportation and the competition of other products. The Eskimos

would have to change from a hunting to a pastoral life and from heat-giving foods like the blubber of seals and whales which they prefer to the lean flesh of other animals. To the extent that climate and soil favour the raising of these animals or of cross-breeds between these animals and domestic cattle, their production should probably be encouraged, if only for the reason that they will give the native a living when trapping is depressed and introduce some variety into his diet. It seems unlikely that "livestock" will ever occupy a large place in the commercial life of the Region.

Mining

The upper arms of the Shield where the Tundra type of vegetation prevails are being developed for their minerals. Gold is mined at Yellowknife, radium at Great Bear Lake, and base metals are known to exist along the Coppermine River.[9] It is doubtful if the northern segments of the Shield are as heavily mineralized as those sections in Ontario, Quebec and Minnesota which have been exploited for several years. Yet new ores will probably be discovered as a result of a more thorough knowledge of the geology of the north and the perfection of geophysical prospecting. These resources can be profitably used only if advances continue to be made in solving the problems of living and working in remote areas under relatively severe climatic conditions, and of maintaining cheap transport connections with markets and sources of supplies.

The economic development of the Tundra raises many problems of an unusually difficult nature. The native Eskimos will likely be the permanent inhabitants and the white man must

[9]Finnie, *op. cit., passim.* See also Robinson, J. L., "Mineral Resources and Mining Activity in the Canadian Eastern Arctic", *Canadian Geographical Journal,* August, 1944, pp. 2-24. Yellowknife is actually in a thinly forested area but, being on the edge of the Tundra, can conveniently be considered with the latter rather than with the Shield.

consider himself to be the trustee of the Region on their behalf. Although the Tundra may be of considerable value to the settled parts of Canada, the fundamental emphasis must be on the long-run interests of the only continuing residents the Region can ever expect to have. This doctrine is easy to accept in principle but opinions as to its practical application differ widely among government officials, missionaries, traders, miners and the general public.

The opening up of Arctic Canada is essentially a problem in pioneer or colonial development. A determined effort is being made to avoid the obvious mistakes which have been made in settling other parts of the Dominion. The problem is shared by Canada with Russia, Finland, Norway (Spitzbergen), Iceland, Denmark (Greenland), and the United States (Alaska).

The rapid exploitation of the northern sections of Russia has attracted considerable attention.[10] Progress in Siberia has been favoured by two factors, the one natural, the other artificial. The Arctic Ocean north of Asia is more free of ice than it is north of Canada because there are few narrow channels and islands off shore. Vessels can navigate the coastal waters regularly during the summer, whereas only two ships, Amundsen's *Gjoa* in 1903-06 and a Royal Canadian Mounted Police boat in 1940-2, also in 1944, have ever crossed north of Canada. Modern Arctic navigation is aided by planes and wireless which collect and broadcast information regarding ice conditions, the strength and direction of the winds and so on. Ships can avoid aimless wandering in search of a passageway through the ice. Yet even in Russia the period of practicable Arctic navigation is short. Its usefulness is further reduced by the fact that, due to the difference in latitude, the ice in the lower stretches of the rivers which flow into the Arctic melts later in the spring and forms

[10] Smolka, H. P., "The Economic Development of the Soviet Arctic", *Geographical Journal,* vol. 80, April, 1937, pp. 327-43.

earlier in the fall than it does in the head-waters. It is not always easy to ship freight down the rivers to the Arctic coastal vessels.

The artificial impetus to development is the threat of attack by way of the Arctic coast. Even if the schemes do not pay in an economic sense, Russia justifies them on strategic and military grounds. This factor, so far, has not significantly influenced Canadian policy. At all events, if the Tundra is to contribute to national welfare without sacrificing the interests of the natives there must be an exchange of information with the other nations concerned with Arctic development and a careful application of all the pertinent knowledge of the sciences of geography, biology, animal husbandry, economics and ethnology.

Chapter IX

NEWFOUNDLAND AND LABRADOR

NEWFOUNDLAND is an island lying just off the northeast corner of North America. It is separated from the mainland by the Straits of Belle Isle which are no more than nine miles wide at one point. It is divided from Cape Breton Island by a distance of 60 miles across the straits of Cabot. The total area is 42,000 square miles or approximately that of Ohio and nearly half that of England, Scotland and Wales together. The Island is part of the British Empire but has never entered the Dominion of Canada.

Newfoundland is shaped like a rough equilateral triangle with sides about 300 miles in length. It is very much indented by fiords and large bays, is skirted by small islands, and has many peninsulas. The interior is a rolling plateau with numberless lakes and small hills. The highest elevations—only a little more than 2,000 feet—are in the Long Range which parallels the western coast. The plateau slopes downward to an average height of about 700 feet in the east. Viewed from the ocean, the coasts appear bleak and rocky. They rise rather steeply from the water to heights of from two to three hundred feet. The ranges of hills, the numerous bays, the short but swift-flowing rivers are all more or less parallel to each other and trend in a southwest to a northeast direction.

Geology

The geological history is not yet worked out in detail. On over half the area Precambrian rocks outcrop at the surface. Elsewhere rocks of the Silurian and Carboniferous periods are

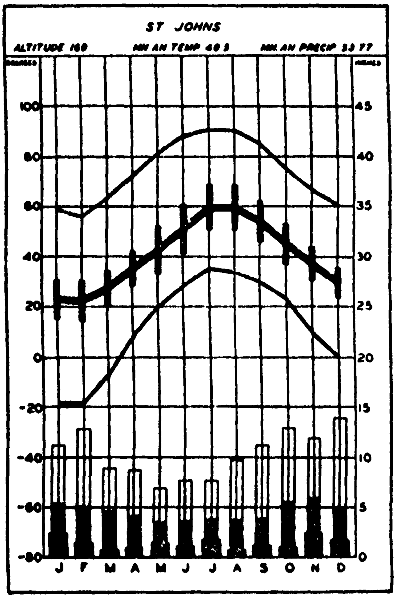
superimposed on the more ancient Precambrian formations. Apparently an ancient mountain chain was worn down by erosion and the stratified rocks were laid down upon it. Eons later the great continental ice-sheet carried away most of the fertile soil which had been formed by the weathering of the surface rocks. The glaciers also gouged innumerable depressions out of the softer rock and eroded the bottom of one of these, now filled by Grand Lake, to a depth 300 feet below the present sea level. Along the coast, tongues of the glacier cut fiords, that is, U-shaped valleys with high, almost perpendicular cliffs and deep water close to shore. When the glacier retreated, it left moraine in thin patches on the surface rock. The depressions were filled with water or swamp vegetation. Rivers tumbled over rocky ledges and, because they have sought out and eroded channels into the softer rocks of the old mountain chain, they have tended to parallel each other.

The geological history has determined the broad course of economic development. The glaciation has been so recent, geologically speaking, that weathering has not been able to create deep fertile soils from the hard crystalline rocks except in one or two areas but over most of the island, the soil cover, though shallow, is adequate for the growth of coniferous forests. Often near the coast trees are absent, due to strong cold winds or to fires started by man. The crystalline rocks contain iron, copper, zinc, and other minerals, while the stratified formations have coal. There is ample water-power. The submerged plateaus off shore give a topography suitable for fishing.

On the whole the geological history of Newfoundland is similar to that of the Acadian area. The fact that Newfoundland is adjacent to one of the world's greatest fishing grounds has directed, if not misled, the course of economic life. "The country has always been, first and foremost, a fishing country".

Climate

The climate of Newfoundland[1] is deeply affected by its position on the leeward side of the continent and its proximity to the cold Labrador current. Northerly winds carry the frigidity of the current across the land. In particular the cold waters surrounding the island cool the atmosphere above them and set up a



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barrier against the penetration of the warm southerly air masses which are associated with cyclonic storms. Consequently spring is delayed. Snow often remains on the ground in shaded spots until June. Summer is cool and foggy; winters long and cool. Due to the encircling waters temperatures above 80 degrees or

[1]Koeppe, *op. cit.*, pp. 170-99.

below zero are rare but the high humidity makes the sensible temperatures, that is, how the surrounding atmosphere feels to an individual, cold and raw throughout most of the year.

Fishing

The fishing industry has long been the mainstay of the island's economic life. In 1497 John Cabot, the first explorer in these parts, reported that the fish were so thick in the water that they almost stopped his boat. Soon fishermen from France, England, Portugal and Spain ventured across the Atlantic to catch fish and return with their cargoes to Europe. By 1578 nearly 400 vessels of all nationalities were engaged in the trade.

Although fishermen skirted the shores for many years, no permanent colonies of importance were established. The shores were bleak and forbidding. The fishermen sometimes went ashore to dry fish or store supplies and boats until they returned in the following year. Frequently they made a cursory search for precious metals but they were interested primarily in the sea and so neglected the land. Later, disputes between Britain and France regarding ownership of part of the coast may have deterred settlement. In any event, colonization was slow and even when settlements were started they were only sickly adjuncts to the fishing industry.

Since the fishing grounds of Newfoundland are, generally speaking, merely continuations of those of the Acadian-Appalachian Regions, the industry is influenced by the same forces. The cold water which stimulates the growth of fish with firm flesh, the ample "pastures" of diatoms and other marine life, the submerged plateaus or banks, the irregular coast-line, and the generally cold climate for preserving the fish are some of the favourable factors. The perishability of the product, the remoteness of the area from large markets, the uncertainty of the catch from one season to another, the dependence on foreign markets,

and fluctuating prices are a few of the drawbacks. The disabilities are even greater in Newfoundland than they are in Nova Scotia because the former is more isolated from markets. Newfoundland does not form part of a large and prosperous Dominion which would assume some of the costs of social services. Except on a limited scale the island has failed to develop its pulp and paper resources and its resources of base metals. It has no coal mining of importance, no iron and steel manufacturing and little overseas trade except in fish. There is no agriculture of significance. In short, Newfoundland is fully exposed to the hazards of a single industry the returns from which have always been notorious for their uncertainty. By contrast, Nova Scotia has broadened her economy so that, although she suffers from the declining prosperity of the fishing industry, she is not entirely ruined by it.

The total annual catch of fish by Newfoundlanders is normally about 1,500,000 quintals of 112 pounds each.[2] Of this total 7½ per cent is obtained from the Banks, 22½ per cent from Labrador and the remainder is secured along the shore. The Banks are exceedingly important when the world's total catch of fish is concerned but they are shared by France, Canada, the United States, Spain, and Portugal as well as Newfoundland. For the island itself the shore fisheries are much more important than the Banks. The methods of catching fish on the Banks and along the shore are substantially the same as those practised by Nova Scotians except that trap nets are more common. The trap net is a sort of cage which is placed off shore where the fish are most likely to be running. The long perpendicular walls of the net are set at a depth best calculated for the purpose of leading the "run" of fish along a steadily-narrowing corridor into a

[2]Newfoundland Royal Commission, *Report* (London: 1933), pp. 94-140; Committee of Enquiry Investigating the Sea Fisheries of Newfoundland and Labrador, *Report* (St. John's: 1937).

pocket from which they cannot escape. The fish are brailed from the pocket or trap daily. Trap nets need constant repair and are expensive to purchase. Because they are fixed at a given point, it is a gamble whether the fish will come or not. The curing of the fish is conducted in substantially the same manner as in Nova Scotia.

Of the total catch, about 200,000 quintals are used locally and the remainder is salted and sold abroad. Normally the chief markets were in the Mediterranean region—Spain, Portugal, Italy, Malta, and Madeira—and also in the West Indies, Brazil and Cuba. These markets have been affected by civil and foreign war, by the competition of other producers, and by the shift in diet from heavily-salted cod fish to more palatable products. Newfoundland has suffered from precisely the same conditions in the salt fish trade as has Nova Scotia and its relatively remote location prevents it from engaging in the fresh fish trade to any extent.

Almost all the overseas trade in fish is in the hands of merchants in St. John's. The business is very speculative and the merchant protects himself by paying as little as he can for the cured fish and by engaging in many types of enterprise. Besides handling fish, he sells food, clothing, and other supplies to the fishermen. Often he advances them credit so that they can carry on their operations during the fishing season. When the fish is sold the debt is repaid. But the individual fisherman usually needs a further supply of credit to carry him over another season. The temptation to take advantage of the weak bargaining position of the fisherman is too strong for unscrupulous merchants to resist. The more responsible merchants have been forced by competition to adopt the same attitude. The result is an iniquitous system which "is sapping the energy, initiative, and moral sense of the people".

Although cod is the mainstay of the economic life, other types

of fish are important. Salmon are caught in gill nets off shore in the spring. They are sent as quickly as possible to a large vessel which is equipped to freeze salmon in brine and which goes northward with the run. Most salmon are sent to Britain in refrigerator ships. The salmon fishery lasts for only a few weeks each year so that it does not provide a permanent livelihood. The trade in lobsters gives a living to about 500 men. Smelts, halibut, scallops, cod-liver oil, and fish meal are other products of the fishing industry. Nevertheless, fishing in Newfoundland is based on cod and the failure of the trade in that article has brought widespread distress. At one time nearly 90 per cent of the population was dependent on the fishing industry. With the development of other occupations the percentage has declined to about 50.

Seals are hunted every spring on the ice floes to the northeast of Newfoundland and in the straits of Belle Isle.[3] Locally-owned vessels especially built for resisting the pressure of the ice and carrying a crew of from 150 to 200 men each steam toward the main "patch" or herd of seals which have been spotted by planes. The vessels force their way into the ice by following the open "leads" between the floes. When the ice begins to close in around the vessel it is broken by the armoured prow and then pushed with long poles along the sides of the ship and out of reach of the propeller where it might do serious damage. If the ice becomes very thick it is cut with saws or dynamited. When the patch is approached, the men leave the vessel and go out on the ice. They kill the young seals which are not yet active enough to escape by knocking them on the head with a gaff and they use rifles to shoot the older seals which are more difficult to approach closely.

[3]Bartlett, R. A., "Sealing Saga of Newfoundland", *National Geographic Magazine*, vol. 36, July, 1929, pp. 91-130; Royal Commission, *op. cit.*, pp. 95-6.

The pelt or sculp of each seal, along with a layer of fat an inch or two thick which clings to the pelt, is removed. The sculps are piled up on the ice, marked with coloured flags and eventually loaded aboard the vessel. When the ship returns to port after a 6 or 8 weeks' voyage, the fat is scraped from the hide, ground, and boiled to secure oil which is used in making soap. The skins are tanned into leather. The Newfoundland seals differ from the so-called seals, really close relatives of the sea-lion, of the Pribilof Islands in the Bering Sea in that they whelp on ice, not on dry land, have hair instead of fur and are used for leather and oil, not for garments.

The catch of seals off Newfoundland is now less than one-third its peak of 700,000 pelts in the 1850's but no really effective measures are being taken to conserve the present resource. Newfoundland's legislation prohibiting commercial sealing except in the spring is largely innocuous because the closed season applies only to periods of the year when there would be no sealing in any event. The chief argument against conservation is that the herd, even at its present size, consumes about 3,000,000 pounds of cod a day and that unless it is regularly reduced in numbers the cod-fishery will suffer. Be that as it may, there seems to be little justification for removing only the hide and fat of the seal and leaving on the ice the remainder of the carcass which should have some value if only as fertilizer.

Agriculture

Agriculture in Newfoundland[4] suffers from much the same handicaps as in the Shield although it lacks anything approaching a Clay Belt. The soils are generally poor because they are composed of the sand and gravel of glacial drift. The most fertile soils are along the west coast around St. George's Bay where the Carboniferous rocks have weathered down into rea-

[4]Royal Commission, *op. cit.*, pp. 5. 164-70.

sonably productive soils. Unfortunately this land is remote from the chief settlements which are located along the east and south coasts nearer the fishing banks and Europe. The climate is unfavourable to many field crops and the long winters militate against the raising of cattle. Nevertheless, in the Avalon peninsula dairying has developed on a limited scale to supply the nearby market in St. John's.

A little farming is carried on in the vicinity of almost every fishing centre. The average fisherman is also a farmer in the sense that, while he is primarily dependent for his livelihood on the products of the sea, he also cultivates a small strip of land in the vicinity of his house. Because most settlements have been located with reference to easy access to good fishing grounds, not to agricultural land, the soils adjacent to some fishing villages are beyond hope of cultivation. The planting of crops often interferes with fishing. In a good fishing season the crops may be neglected entirely. At present few fishermen give any serious attention to their gardens and only about two-fifths of one per cent of the total area of the island is in crops. Had they a mind to, the fishermen could raise their own hardy vegetables like potatoes, cabbage, turnips, beets and carrots, besides keeping a pig or two and a few hens. In this way they could lift their own standard of living, improve their diet and their general health, and relieve their excessive dependence on fish. The government is doing a good deal to encourage subsistence agriculture but its efforts are hampered by the inertia of the fishermen, their pre-occupation with fishing, and the natural limitations of climate and soil.

Mining

Mineral resources are of some importance in Newfoundland.[5] On Bell Island, six miles long and two miles wide, in Conception

[5] *Ibid.*, pp. 156-63; Shaw, E. B., "Population Distribution in Newfoundland", *Economic Geography*, vol. 14, July, 1938, pp. 243-5.

Bay, the largest iron ore reserve in the British Empire is exposed at the surface. The bed of ore extends out for long distances under the bay. This Wabana deposit, as it is commonly called, is a dense, fine-grained ore with a ferrous content of 52 per cent and only small traces of impurities which are harmful in producing good-quality pig iron. In 1929 the output was 1,500,000 tons, of which 57 per cent was sent to Germany, 38 per cent to Canada, and the rest to Britain and the United States. In the depression of the 1930's production was cut drastically but recovery was rapid due to the high quality of the ore and the ease of transport abroad.

In 1907 lead-zinc ore was discovered at Buchans near Red Indian Lake in the centre of the island. Since the ore body was of the same complex character as the lead-zinc deposits of the Shield, it could not be used until the perfection of the flotation process. Since 1925 large amounts of lead, zinc, copper, silver, and gold have been recovered. The value of the total output reached nearly $7,000,000 in 1928. The costs of operation are so low that the mine continued to be worked throughout the depression. In 1934 it was estimated that the mine would have a working life of another fourteen years. Newfoundlanders hope that other resources of similar ores will be discovered elsewhere before depletion of the Buchans mine. Deposits of copper, silver, nickel, chromium, antimony, asbestos, and vanadium have been found but not in commercial quantities.

On the west coast near St. George's Bay there is a reserve of 147,000,000 tons of good-quality bituminous coal. The resource has been exploited to only a limited extent. It is remote from the settled parts of Newfoundland. There is ample wood throughout the island for domestic heating and there are no large industrial or commercial buildings. The existence of better grades of coal across the straits of Cabot in Cape Breton Island is also a handicap on development in the St. George's area.

Forestry

Fine-quality black spruce, balsam fir, and other coniferous trees cover most of the interior wherever the soil is reasonably good. These trees form the basis for a small but important newsprint industry.[6] In 1909 the Harmsworth family of newspaper publishers in London and other British cities established a newsprint plant at Grand Falls near the east coast. In 1925 an American firm set up another mill at Corner Brook, though their financial interest has since been purchased by a British group. These two companies have leased more than half of the forested land on the island. There is no scientific afforestation programme but the companies feel sure that their system of rotational cutting will guarantee a permanent business.

The newsprint industry has the advantages of cheap wood, low-cost hydro-electric power and low-priced labour. The rivers provide economical transportation for the logs and both mills have cheap transportation to markets in London and New York. The mill at Corner Brook is located on an estuary open to navigation for most of the year. The plant at Grand Falls is located inland near a power site and sends its finished product by rail to Botwood for export. Each mill supports a population of about 5,000 people in nearby towns. Newfoundlanders are anxious to increase the number of newsprint plants on the island but their efforts toward attracting capitalists have not been successful so far.

With the exception of small quantities of pit props to Wales, there is no export of lumber. The forest resources along the coast are used by fishermen for fuel and for building houses, boats, and wharfs. Fuel and lumber is also shipped to St. John's.

[6]Royal Commission, *op. cit.*, pp. 141-56; Shaw, *op. cit.*, pp. 245-6.

Fur Trade

The fur trade of Newfoundland has never been as important as in Canada. The number of the fur-bearing animals has been seriously depleted until now beaver, once flourishing, are almost extinct and mink and fox have been reduced to small proportions. "The experiment with reindeer which was carried out by Sir Wilfred Grenfell in the north of the island proved at first highly successful, but when the herd had increased from 300 to 1,500, the greed of the inhabitants, and their instinctive desire to kill any animal on sight, could no longer be restrained. Within a few months four-fifths of the animals had been slaughtered, and the experiment had to be abandoned."[7]

General

Newfoundland has probably never been a thoroughly prosperous community. The waters of the Grand Banks provided a livelihood to hardy fishermen from Europe as early as the sixteenth century but the land itself was passed by, due to the obvious inhospitality of the shores and the fact that wealth could be obtained more quickly farther west. The early settlements along the coast were merely places where fishermen landed to repair their nets, dry fish, or store supplies until they came back from Europe where they sold their catch. Even when people began to live on the island permanently, their entire outlook was toward the sea and their prosperity was solely dependent on the cod-fishery. Settlements were located with reference to the ease of catching fish and exporting them to Europe. As it happened, these sites were not near good-quality soils. There was no chance of integrating agriculture and fishing so that one might prove an economic bulwark to the other. The result was that the whole economy of the island became hinged to an industry which is notoriously uncertain in respect to output and selling prices.

[7]Royal Commission, *op. cit.*, p. 93.

Moreover, this industry has gone into steady, long-run decline in volume due to changes in diet.

A further handicap on the island's development has been its small population, which is divided by distance and religion. The population of the island numbers less than 300,000 of whom 40,000 are in St. John's and the rest are scattered around a coast-line of 6,000 miles. The interior is almost uninhabited except for a few mining centres. The wide dispersion of the settlements makes the administration of the government and the provision of medical and social services difficult and expensive. The only means of communication between most of the settlements is by sea and this is hazardous especially on the north coast during the cold, raw winter. "Enforced isolation has given rise to intermarriage, chronic disease through the absence of medical advice, and gradual degeneration".[8] The situation is made worse by the fact that education is on a denominational basis. In an area where the cost of education would be high in any event, it is unfortunate that there should be duplication in many villages of schools operated by the Anglican, United (Methodist) and Roman Catholic churches, which share almost equally the religious allegiance of the people. The denominational influence has also affected the award of contracts by the government and appointments to the civil service.

The precarious character of the island's economic foundations was realized before the end of the nineteenth century. In 1895 all the local banks failed due to the collapse of the fishing industry. Canadian chartered banks had to go in to provide the community with banking and currency. Because the construction of railways had led to prosperity in Canada and the United States it was natural that Newfoundlanders should turn to railway building as a solution to their difficulties. The government gave financial assistance to a British capitalist for the construc-

[8] *Ibid.*, p. 73.

tion of a line from St. John's to Port aux Basques where steamship connections could be made with Sydney, Nova Scotia. Unfortunately the contract was improvident from the people's standpoint. The railway runs through the interior plateau, which is unpopulated for long distances. No careful survey was made of the resources of the interior before the road was built and so it misses most of the mineral and forestry resources which the interior possesses. The line touches only a few of the coastal settlements and is of no value to the fish trade. The road—a narrow-gauge one—is expensive to operate and is often weather-bound. Finally, the railway saddled the population of the island with a debt far beyond its capacity to bear.

In the 1920's the colony was carried away by the "boom" psychology prevalent throughout North America. The erection of a newsprint mill, the opening of the Buchans mine, the award of a large area in Labrador by the Privy Council to Newfoundland, and the possibility of attracting tourists gave the populace exaggerated ideas of the potentialities of the island. "The fact that the fisheries were, and must remain, the basis on which the island's economic structure rests was overlooked. Lavish expenditure on any object but the fisheries was considered justifiable".[9]

In the 1930's the cod-fishery became so badly depressed that there was danger that the colony would have to default on its public debt. In 1932 one-quarter of the population was on relief. Despair among the population was common and the local government, bogged down by lack of revenue, by excessive denominationalism and by the feeling of the hopelessness of its past efforts, seemed incapable of dealing with the multitude of problems which beset it.

In order to prevent the utter ruin of the colony, Great Britain and Canada advanced money to forestall default and in 1933 the former appointed a Royal Commission to investigate the

[9] *Ibid.*, p. 93.

entire problem. As a result of its recommendations[10] the right of the colony to virtually complete self-government was held in abeyance until more propitious times. A commission of six was appointed to manage the island's affairs temporarily. The financial advance by Canada was repaid and further deficits on the operation of the government in the island are to be borne by the United Kingdom. Although three of the Commission of Government are Newfoundlanders, the most important departments —Natural Resources, Public Utilities (the government railway), and Finance—are in the hands of members of the British Civil Service. The Commission has tried to improve the lot of the people by working in many directions, encouraging agriculture, improving the cure of the cod-fish, cutting out waste in government and so on. Their efforts have been well meaning but only moderately successful. The average net earnings of a fisherman after expenses for gasoline, salt, repairs to boat and nets had been paid but before interest on his investment or wages for himself were only $61 in 1937 and $86 in 1938. Many families were still on relief. The work of the Commission has been the subject of much controversy.[11]

The second World War created a fictitious prosperity in the colony. A thriving market for newsprint and minerals opened up. The construction of aeroplane and naval bases on the island gave employment to all. What will happen after the war is over is problematical. The islanders hope that the increase of trans-Atlantic air travel will provide employment, because the island is practically the last point of land in North America on the Great Circle route between Montreal and New York and the large cities of Britain and northwestern Europe. The difficulty is that once the airfields and seaplane bases have been constructed

[10] *Ibid.*, p. 197.

[11] Lodge, T., *Dictatorship in Newfoundland* (London: Cassell & Co. Limited, 1939); "Government by Commission in Newfoundland", *Round Table*, vol. 29, September, 1939, pp. 705-18.

the servicing of planes will create little employment. The long-range planes now being perfected may be able to fly non-stop between the large cities of the two continents and Newfoundland will then become no more than an emergency landing field. At all events, the war has been in the nature of an "economic cyclone" to the island, to borrow a term fittingly applied by Professor Innis to the Klondike gold rush.

Although Newfoundland is a loyal member of the British Empire, she is not part of the Dominion of Canada. When the various colonies in British North America joined to form the Dominion in 1867, it was assumed that Newfoundland would become another province in confederation but the proposal was rejected by the legislature of the island colony. At the time of the banking collapse in 1895 the proposal was re-considered. The Dominion offered the colony the most favourable financial terms given to any province already in the confederation but as these terms would still leave Newfoundland with a heavier debt than any province, they were rejected. From time to time the proposal of admission into the Dominion has been revived in various forms but the question has ceased to be a live political issue in the island. The present attitude is that the island will join the Dominion only when she is sufficiently strong financially. She will never apply for admission as long as she is poverty-stricken. Some Newfoundlanders are suspicious of the centralized Government in Canada. Others fear that their merchants could not compete with Canadian mail order houses and that the tariff would adversely affect them. St. John's is four days distant from Ottawa and six from Liverpool. The relative lack of prosperity in the Maritime provinces of Canada is a strong deterrent. "The people of Newfoundland would much prefer to be masters in their own home, however poor, than to play the part of Cinderella in the Canadian mansion".[12]

[12] *Ibid.*, p. 189; Lacey, A., "Canada's Tenth Province", *University of Toronto Quarterly*, vol. 12, July, 1943, pp. 435-45.

Although Newfoundland is not a province of Canada, the connections between the two separate political units are intimate. Canadian banks, trust companies, life insurance concerns and some other business firms operate on the island. Canadian bank notes provide the only circulating medium other than the subsidiary silver coins of the local government. Canada absorbs some of the colony's exports, notably of iron ore, and provides about one-half the imports of the island. The religious connections are close, an important factor in view of the strength of denominational influence in the island's affairs. The mere fact of propinquity and the existence of similar economic and social problems makes for close connections. Above all, there is loyalty to a single crown and the community of feeling which grows out of membership in the British Commonwealth of Nations.

Labrador

Labrador, on the mainland of North America, is a political dependency of Newfoundland. The precise location of the boundary between this territory and Canada was uncertain until 1925. In that year the Judicial Committee of the Privy Council, which is the highest court of appeal to British subjects and governments outside the United Kingdom, set the boundary far inland from the coast. The total area of Labrador is 110,000 square miles or nearly three times that of Newfoundland.

Labrador is geologically an extension of the Canadian Shield, which it closely resembles in topography. Along the coast there are several fiords of which Hamilton Inlet is the most prominent. The climate is similar to that in Newfoundland though the temperatures are somewhat lower and there is a greater proportion of sunshine. The coastal strip and the islands off shore are barren due to the cold, bitter winds blowing from across the cold waters to the north. Inland there is a heavy forest cover along the streams, where the soils are better and there is some protec-

tion from the winds but most of the interior is covered with light timber or with shrubs or else is swampy or barren.

The most important economic resource of Labrador is fish which are caught along the cold waters of the coast from July to September or October.[13] About 800 families, called liveyeres or stationers, live along the coast throughout the year. They spend their summers fishing from dories which go out from shore daily, and in winter they trap fur-bearing animals. In addition, a variable number of "floaters" come every summer from Newfoundland to fish from schooners and dories as on the Grand Banks. The floaters return to Newfoundland with their catch but the liveyeres sell what they have caught to vessels which travel along the coast for the purpose of bartering fishing requirements and household supplies for fish. Since the supply vessels visit the coast at irregular intervals, the fish must be sold whether or not the cure is complete. Often Labrador fish are treated with an excess of salt. Sometimes, because timber is so scarce, the fish are spread directly on the rocks to dry, and since the air cannot circulate underneath the fish, the quality is poor. Generally speaking, the economic condition of the liveyeres is poorer than that of fishermen in Newfoundland and Nova Scotia although some have comfortable if unpretentious homes. Sir Wilfrid Grenfell and his successors have brought medical care, education and hope to large numbers of fishermen and their families along this forbidding coast.

The 30,000 square miles of forests with trees of merchantable size are a potential source of wealth for pulpwood and pit props. Black spruce along Hamilton Inlet and River has already been used to a limited extent.[14] One saw-mill successfully exported lumber to Britain but operations were abandoned because the

[13] *Ibid.*, pp. 100-1.

[14] Kindle, E. M., "Notes on the Forests of Southeastern Labrador", *Geographical Review*, vol. 12, January, 1922, pp. 57-9.

workers, who were chiefly Englishmen, could not tolerate the black flies of summer and the cold and isolation of winter. French-Canadian workers would have been more suitable. The forests are of good quality, timbers of nearly 60 feet length being sometimes produced. The resource is nearer Europe in terms of miles than any other in North America but is remote in the sense that it is not near a well-established port or steamship service.

The liveyeres trap mink, weasel, marten, and fox during the winter but the volume of the fur trade is not large. Agriculture is limited for obvious reasons. Sir Wilfred Grenfell believed that it could be carried on on a limited scale if the soils were sweetened by lime from shells along the shore and if some vegetables were started in hot-houses before transplanting in the spring.[15] In this way the people could improve their diet which at present is confined to fish, wild animals, berries which grow in profusion, and bread from flour purchased from the supply vessels. Reindeer would probably thrive if the hardy Alaskan species were selected and the natives taught to care for them properly.

Labrador's Precambrian rocks may contain valuable minerals. Large reserves of good iron ore were recently discovered. The territory has huge potential resources of hydro-electric power. Grand Falls alone can produce 4,500,000 horse-power. The power sites are so remote from industrial centres that they are unlikely to be used. Probably the future of this resource lies not so much in colossal engineering and industrial projects as in the integration of power and forestry with supplementary employment in agriculture, trapping and fishing.[16] Development lies more in the direction of the modest but sure prosperity of Finland and Sweden

[15]Grenfell, Sir W., "The Problems of Labrador", *Canadian Geographical Journal,* vol. VII, November, 1933, pp. 200-12.

[16]Forbes, A., "Rivers of the South Shore of Lake Melville, Labrador", *Geographical Review,* vol. 30, July, 1940, pp. 394-9.

than in the more spectacular but erratic industry of North America.

Newfoundland, overwhelmed by adversity, is somewhat embarrassed by the size and undeveloped resources of her continental dependency. It has been suggested[17] that the territory be ceded either to Canada or Great Britain in return for a lump sum or for the transfer of part of the island's debt. Another proposal is to lease the territory to a trading company which, in return for an annual rental, would develop the resources commercially. The Commission in 1933 recommended that Labrador be retained by Newfoundland for the benefit of future generations.

[17]Royal Commission, *op. cit.*, pp. 184-6.

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